FARRAGUT STATE PARK NATURAL RESOURCE PLAN AND GIS DATABASE

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CHAPTER 1: FARRAGUT STATE PARK

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Farragut State Park is located on the southern tip of Lake Pend Oreille in Kootenai county. The park is 3,929 acres in size (Figure 1). The park provides visitors views of open meadows, dry conifer forests, wet conifer forests, and many wildlife species. It is a destination for local residents and campers in the summer and winter. Spring, summer and fall provide for hiking, target shooting, bicycling, disc golfing, swimming, boating, windsurfing, fishing, model plane flying, and archery deer hunting activities. Winter activities include cross-country skiing and sledding. Anglers can fish for yellow perch, kokanee salmon, Gerrard rainbow trout, brown trout, westslope cutthroat trout, lake trout, lake whitefish, mountain whitefish, largemouth bass, smallmouth bass, black crappie, pumpkinseed sunfish, and bullhead. Wise management of these diverse resources is a complex and rewarding challenge. This document provides an inventory of resources and management prescriptions for current ecological and management issues existing within Farragut State Park.

I. LOCAL AND REGIONAL HISTORY

The first known inhabitants of the Lake Pend Orielle area and Farragut State Park were the Pend Orielle Indians. They are part of the Salishan Language Family and relatives of the Coeur d' Alene, Flathead, and Spokane tribes. Their name for Lake Pend Orielle was Kalespelm. The Pend Orielle people were migratory and lived by hunting, fishing, and gathering. Their homes were circular pit dwellings covered with light superstructures and earth. The Coeur d' Alene, Flathead and Spokane tribes also were frequent visitors to Lake Pend Orielle (ORB 1975).

The first European to enter the area was David Thompson of the Canadian owned Northwest Company. Thompson explored the Pend Orielle area for a short time period in 1808. He left and came back in 1809 to build a trading post called the Kulyspell House. The Kulyspell House was located north of the mouth of the Clark Fork River near present day East Hope, ID. The house was the first to trade with the Pend Orielle tribe. It was open for 2 years and closed in 1810. In 1850, the Pend Orielle area was included as part of the Washington Territory. Lake Pend Orielle served as a part of the mail route between Walla Walla and Missoula in the 1860's. Three steamboats from Steamboat Landing near the head of Idlewilde Bay transported cargo and mail to the other side of the lake. Prospectors and the Northern Pacific Railroad came into the area in the 1880's. Timber exploitation started in the 1900's. The lake was used to transport logs to Sandpoint, ID. Excessive logging and the Great Idaho Fire of 1910 depleted timber resources in the area. The 1910 Fire consumed over 3,000,000 acres of forests and ended the timber industry. The area was mainly used for recreating until the 1920's when a lime rock quarry was started at Lakeview, ID and a limekiln at Bayview, ID. These businesses died by 1939. The Prohibition Era from 1920-1933 also touched Lake Pend Orielle. The lake was used at night by "rum runners" to transport illegal bottled goods from Canada to the U. S. However, during the first 40 years of the 20th century, the Lake Pend Orielle area was primarily a destination for tourists, fisherman, hunters and recreators (ORB 1975).

World War II caused major changes in the use and the scenery of the region. President Roosevelt talked to Idaho governor Chase A. Clarke in the spring of 1942 about establishing a naval training station on Lake Pend Orielle. The U. S. Navy acquired private holdings from Bayview, ID to Buttonhook Bay, ID. Construction of the Farragut Naval Training Station began on April 10, 1942. The base was named after Admiral David Glasgow Farragut who won the Battle of Mobile Bay during the American Civil War. Farragut commanded the U. S. S. Hartford and defeated the C. S. S. Tennessee on August 5, 1864. It took four years to build the base and required 22,000 workers to construct it. The base cost $100 million dollars and became the second largest base in the world at that time. Naval personnel arrived on August 9 to prepare the camp and opened 6 training camps within six months. The six camps were the following: Bennion, Ward, Waldron, Hill, Scott and Peterson. Five thousand men were stationed at each camp. Twenty-two two-story barracks, a mess hall, two dispensaries, recreation buildings, ship's stores buildings, an indoor rifle range and regimental headquarters were part of each camp (Glans 1992, ORB 1975).

II. ENABLING LEGISLATION FOR DEPARTMENT AND PARK

A. AUTHORIZATION OF FARRAGUT STATE PARK

On June 6, 1946, Farragut Naval Training Station was de-commissioned, as surplus to U. S. military needs. Farragut College and Technical Institute established itself in the fall of 1946 and existed until 1949. The State of Idaho acquired the land in 1950 and it was assigned to the Idaho Department of Fish and Game as a Wildlife Management Area. In 1964, 2,566 acres were transferred back to the U. S. government. They in turn transferred it to the Idaho Department of Parks and Recreation as Farragut State Park, part of the new department, for public park and recreation purposes. Later, 79.7 acres of abandoned railroad right of way were transferred back to the U. S. who transferred it to Kootenai County as a public recreation trail. In 1991, IDPR purchased 5.07 acres of private land adjacent to the park. Today, IDFG and IDPR cooperatively administer by agreement 1412.4 acres of Farragut Wildlife Management Area, in cooperation with Farragut State Park administration of 2,516.6 acres (ORB 1975).

B. CREATION OF THE DEPARTMENT

The legislation for the Department of Parks and Recreation was passed in 1965. Idaho Code Section 67-4219 provides:

> It is the intent of the legislature that the department of parks and recreation shall formulate and put into execution a long range, comprehensive plan and program for the acquisition, planning, protection, operation, maintenance, development and wise use of areas of scenic beauty, recreational utility, historic, archaeological or scientific interest, to the end that the health, happiness, recreational opportunities and wholesome enjoyment of the life of the people may be further encouraged. The legislature finds that the state of Idaho and its subdivisions should enjoy the benefits of federal assistance programs for the planning and development of the outdoor recreational resources of the state, including the acquisition of lands and waters and interests therein. It is the purpose of this act to provide authority to enable the state of Idaho and its subdivisions to participate in the benefits of such programs.

The absence of an adequate and orderly planning process combined with uncontrolled development in Idaho's recreation facilities would reduce the quality of recreation opportunities within Idaho. Consequently, the legislature directed the Idaho Department of Parks and Recreation to formulate and execute a long range, comprehensive plan and program for the acquisition, planning, operation, maintenance, protection, development, and wise use of public recreation areas in order to produce quality facilities for Idahoans and visitors to the state. This planning and development process is to be applied to all new and existing parks within the Idaho State Parks System.

III. DEPARTMENTAL NATURAL RESOURCE POLICIES

A. LWCF ACT

Since funds from the Land and Water Conservation Fund (LWCF) have been provided to support development of Farragut State Park, the park is covered under section 6(f) of the Land and Water Conservation Fund Act. Under the provisions of this act, the park cannot be converted to any use other than for public outdoor recreation without prior approval of the Secretary of Interior.

B. RULES FOR OPERATION OF THE STATE PARKS SYSTEM

Rules, which apply directly to natural resource management concerns, are listed below. Other rules refer to public behavior, lease administration, and fees within state parks.

Preservation of Public Property (IDAPA 26.01.5): The destruction, injury, defacement, removal or disturbance in or of any public building, sign, equipment, monument, statue, marker or any other structures, or of any tree, flower, vegetation or any other public property of any kind is prohibited unless authorized by the Park Manager of a specific area.

Protection of Wildlife (IDAPA 26.01.16): All molesting, injuring, or killing of any wild creature is strictly prohibited, except as provided by action of the Idaho State Park and Recreation Board and the Idaho Fish and Game Commission.

C. TIMBER MANAGEMENT POLICY ON STATE PARK LANDS (PAR. 5:73)

Trees individually or combined in groves or major stands contribute to the scenic and aesthetic values of a recreation area. A tree of twelve inches or more in diameter represents a major investment and cannot be replaced generally, except by an investment in time. For these reasons, our objective will be to retain the individual trees and various stands of timber in as near a natural state as possible, including snags that are important to cavity nesting birds. The following 10 rules are applied to trees and forest patches within Idaho State Parks:

1. Each tree considered for removal will be judged on its own merits.
2. Safety of the recreating public will be a major concern and any tree in a deteriorated physical

condition in a high-use location that creates a human hazard will be removed.

3. Damage to the rest of the stand through disease or insect infestation shall be sufficient cause for the removal of the infested trees.
4. Infestations dangerous to the residual stand, but capable of treatment without the loss of the tree, will be treated by the park staff or in widespread situations, as a cooperator with other timber groups.
5. Fire killed and blown down timber usually involves a considerable volume of timber and frequently becomes a source of damage by insects and disease to the rest of the stand. Trees of considerable volume will generally be salvaged for the protection of the stand. Isolated trees that do not represent a hazard to the remaining stand may be left if it is not undesirable aesthetically and if the cost of removal is excessive. Fire killed and blow-down material should be salvaged when advisable at the earliest opportunity to retain as much of the quality of the timber as possible.
6. Trees may be removed from right-of-way clearings or other construction areas requiring open space. Considerable care will be exercised to limit the damage to the remaining trees. Only those trees will be removed which will be essential to the development.
7. Layout plans will give full consideration to saving unusual, historical, or other trees significantly important, aesthetically, to the park area.
8. Under special circumstances, timber may be cut and harvested to reestablish an essential game range, to establish or preserve a spectacular view, to retain a desirable species, or to change the type to a species more suitable for park needs.
9. Under no circumstances will the commercial value of a tree within the park be considered as criteria for its removal.
10. The department in accordance with established procedures may sell salvaged material from the trees removed under the above policy.

D. 2001 PARK BOARD MISSION STATEMENT

The Idaho Department of Parks and Recreation Board has the following mission for governing the public park lands of Idaho:

1. To promote the general welfare and enhance the quality of life for present and future generations by developing and protecting, where needed the state's significant natural and cultural heritage.
2. To promote the appropriate use of recreation as a means of enriching society and the wholesome enjoyment of life.
3. To provide a balance between individual rights and what is best for the common good.
4. To educate and lead people to a part of the natural world.
5. To touch the lives of all Idahoans in some positive way.
6. To work with other agencies and groups who are interested in the goals we may have in common.
7. To maintain close contact with constituent concerns and present these concerns to the department.
8. To be visionary in providing policy, direction, and leadership to staff.
9. To advocate adequate funding for the agency's activities.

Farragut State Park’s mission is to provide park visitors with an environment, which fosters outdoor recreational, historical, educational, and cultural experiences, and to protect park resources for all citizens.

IV. THE FARRAGUT STATE PARK MASTER PLAN

The Idaho Department of Parks and Recreation (IDPR) assessed the infrastructure, natural resources, and future development opportunities of Farragut State Park. ORB (1975) created a master plan, which reviewed the regional and park history, climate, geology, hydrology, topography, soils, vegetation, wildlife, park facilities, neighboring lands, visual assessments, and recreational demands. The master plan designated present land uses and proposed future development opportunities. The Farragut State Park GIS database also provides an inventory of park resources. Unlike the master plan, the inventory is spatial and digital. It is linked to real world coordinates and associated attribute data (spreadsheets, text files, and photographs). The GIS database lets managers analyze and combine data. This ability is useful for problem identification, problem solving and communication. The master plan is unable to perform this task. However, the master plan possesses valuable information, which is useful to a manager. The master plan should be used in conjunction with the Farragut State Park GIS Database and Natural Resource Plan.

V. NATURAL RESOURCE MANAGEMENT GOALS FOR FARRAGUT STATE PARK

Farragut State Park (including the parts owned by IDFG) serves as an example of the effects created by a combination of historical use by humans, natural events, management to preserve small portions of natural communities, and some recent efforts to allow the natural communities to restore themselves. Historically, parts of the park were effected by:

- Farragut Naval Training Station development
- Steamboat landings
- Farm homesteads
- Commercial logging
- Grazing
- Wagon, automobile, and railroad routes
- Gravel mining
- Landfill
- Wildfires and wildfire suppression

When the land became Farragut Naval Training Station, extreme soil disturbance on 1,322 acres created long lasting effects on the land. Invading plant species, which are adapted to disturbed soils, are prolific and dominant on these disturbed soils. These disturbed acres will be managed to promote a semblance of native vegetation and for park facility development. This will help protect the remaining undisturbed areas, which still have native soil. All the undisturbed soil areas will be managed to meet natural resource goals, which have been developed by Farragut State Park staff and are listed below:

1. To protect natural communities.
2. To conserve biological diversity by protecting habitats for plant and animal species.

3. To restore and maintain natural resources as representative examples of Idaho's original natural systems.
4. To conserve soil resources.
5. To provide wildlife viewing opportunities by protecting, managing, and creating habitat.
6. To provide aesthetic environments and recreation opportunities for people.
7. To stop the invasion of new invading species, and reduce the domination of existing invading species.
8. To manage the property as an ecological community, including IDFG lands.

Figure 1. Farragut State Park is located on the southern tip of Lake Pend Orielle in northern Idaho.

CHAPTER 2: DESCRIPTION OF PARK RESOURCES

The official size of Farragut State Park is at 3,929 acres (Figure 1). Calculations from the geographic information system (GIS) database have Farragut at 3,951 acres. The discrepency is due to error in position accuracy of the park boundary map in the GIS database. Spatial analysis of natural resource issues were conducted with the GIS database, so the natural resource plan uses the 3,951 acre measurement. This chapter describes the climate, geology, topography, natural resources, and cultural resources of Farragut State Park. Natural resources include vegetation, sensitive plant species, forest fuels, water, soils, and wildlife. Cultural resources include ownerships, structures, transportation networks, and utilities.

I. CLIMATE AND WEATHER

Northern Idaho has a continental climate that is moderated by oceanic influences from the Pacific Ocean. Prevailing westerly winds bring moist maritime air from the Pacific Ocean through the Columbia Gorge and up into northern Idaho. The air moves over the panhandle and is stopped by the Bitterroot Mountains and Coeur d' Alene Mountains. The Bitterroot Mountains are west and north of Farragut State Park, while the Coeur d' Alene Mountains are east and south. Occasionally in the summer, moist air comes from the north at high levels and produces thunderstorms. Thunderstorms blow in quickly and build up against the Selkirk Crest. Eventually, these storms move north or south and leave the area over a pass. These episodes cause extreme highs in the valleys. Thunderstorms occur in late May through August. The Lake Pend Orielle area averages 16 thunderstorms a year (Cooper et al. 1991, ORB 1975).

Spring is chilly with frost occurring through May. Temperatures warm rapidly in June due to longer days and normal air masses out of the south and southwest. Dry Chinook winds bring warm, dry air from Wyoming and southern Idaho and melt and evaporate snow. Summers are warm and mild, but can also have periods of hot weather. The average temperature in the summer is 65.0^{o} F. The valleys are much warmer then the mountains. Temperatures will cool in the fall and frosts will occur in September. Winter is from November to March. The valleys are colder then the lower mountain slopes due to cold air drainage. The average temperature in the winter is 30.6^{o} F. Winter winds come from the north and bring cold, wet air into the area. Occasionally storms rapidly descend on the lake and winds can reach up to 60 mph. The high waves generated by these storms are dangerous for boaters (Cooper et al. 1991, ORB 1975).

The Lake Pend Orielle area is moderately humid and has a mean annual precipitation of 30.16 inches. Most of this precipitation comes in the winter months as snow. Annual seasonal snowfall is 59.3 inches. The largest amount of snowfall is in December and January. Snow can remain on the ground until March or early April. Spring and summer precipitation is moderate at 10.84 inches (Cooper et al. 1991, ORB 1975).

II. GEOLOGY, TOPOGRAPHY, AND HYDROLOGY

The bedrock and rock material in the area are from three geologic time periods: pre-Tertiary, Tertiary, and Quaternary. The pre-Tertiary rocks are sedimentary formations that have been metamorphosed and displaced by igneous rocks. These formations were eroded away to form the ridges and valleys of the highlands. The Tertiary rocks are the lake deposits of the Latah Formation and the basalt of the Columbia River Group. Basalt flows dammed the "Rathdrum River", which formed lakes and the Latah Formation deposits. Glaciers and catastrophic floods occurred in the Pleistocene (Quaternary). Advances and recessions of the Cordilleran ice sheet deepened the valleys, smoothed off valley walls, and removed most of the Latah Formation and Columbia River basalt from the Rathdrum Prairie and Athol areas. Ice dams created large glacial lakes. When the dams broke, the floodwaters modified pre-existing deposits in the valleys and removed clays, silts, and sand. Large quantities of alluvium (beds of coarse gravel and rock) were deposited in the valleys. The alluvium was derived from nearby highlands and mountains (ORB 1975, Weisel 1980, Cooper et al. 1991).

Today, the alluvium-filled valleys are the major topographic feature in and around Farragut State Park. The Selkirk Mountains are to the west and north of Farragut, while the Coeur d' Alene Mountains are east and south. The highland and mountain areas were formed from differential erosion of the bedrock. The lowlands have a flat or rolling topography and have no surface drainage due to the permeable composition of the soil material. The pre-Tertiary rocks have low permeability and are an impervious layer underneath Farragut State Park and the Rathdrum Prairie. The bedrock surface beneath the lowlands has the shape of a deep river valley and was at one time occupied by the "Rathdrum River". Farragut State Park is above this old river channel. Ground water is derived from stream flow out of the mountains and highlands onto the lowlands, precipitation on the lowlands, and seepage from lakes on or adjacent to the lowlands. The water disappears through the permeable surface rock layer into the underground "Rathdrum River" channel. Ground water flows west from the lake toward Athol and then flows southward toward Coeur d' Alene. The flow of ground water is almost on a flat gradient. When Lake Pend Orielle declines in depth below the adjacent water table, a ground water divide is formed in the vicinity of Farragut State Park. Sometimes ground water will flow back toward the lake (ORB 1975, Weisel 1980, Cooper et al. 1991).

Farragut State Park ranges in elevation from 2,051 ft along the water to 2,953 ft in the southeastern part of the park (Figure 2). The topography of Farragut State Park is generally flat and undulating, except for around Lake Pend Orielle where it rises rapidly from the shoreline (Figure 3). Over half (55%) of the park has a northern (north, northeast, and northwest) aspect. Southern aspects compose a large percentage of the park at 32%. West and east aspects compose the remaining 13% (Figure 4). Slopes above 35% are almost non-existent and compose 0.2% of the landscape. Recreational development is limited to slopes below 25%. Forest harvest operations need to be modified to yarding systems on slopes > 35% (Figure 5). Consequently, restoration harvesting and recreational development are not affected by slope in Farragut State Park.

III. SOILS

There are eight soil types within Farragut State Park. The characteristics of these soils were determined by the interaction of parent material, climate, topography, living organisms, and the time these forces acted on the soil material. The soil map units represent one or more major soils and some minor soils. The units are named after the major soils. The soils that make up one unit can occur in other units but in a different pattern. The map does not show the kind of soil at a specific site, due to its small scale. Soils within a unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management. Soils that have similar soil profiles make up a soil series. Except for the allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations. A soil complex consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. A soil association is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from unit to unit; nevertheless, interpretation can be made for use and management of the soils. Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. The soil units were broadly defined and verified by some observations (Weisel 1980). The following soil types are present in Farragut State Park (Figure 6):

- Bonner gravelly silt loam
- Bonner silt loam
- Dyrstrochreptic Arents
- Kootenai-Bonner complex
- Kootenai cobbly silt loam
- Kootenai gravelly silt loam
- Rathdrum-Bonner complex
- Vasser silt loam

Soil properties and uses are described in the next section of this document. The Soil Survey of the Kootenai County Area, Idaho by Charles Weisel (1980) provides further information on building site development, sanitary facilities, road construction materials, water management, and recreational facilities.

A. BONNER GRAVELLY SILT LOAM

Farragut State Park consists of 812 acres of Bonner gravelly silt loam (Figure 6). It is a very deep and well-drained soil found on terraces, terrace escarpments, and steep slopes. The soil was formed in glacial outwash with a granite, gneiss, and schist origin. It has a mantle of volcanic ash and loess. Bonner gravelly silt loam supports the grand fir habitat type (see Habitat Types). On level slopes, this soil is suitable for recreation. However, areas can become dusty, if plant cover is limited in these sites. In addition, the high content of volcanic ash make this soil type highly susceptible to compaction, which affects construction and logging operations. Recreation opportunities are limited to trails on steep slopes. Building development can be accomplished on level ground with one limitation: seepage from septic tank absorption fields. This seepage can result in the contamination of ground water and promote frost heaving (Weisel 1980).

B. BONNER SILT LOAM

Bonner silt loam composes 945 acres of Farragut State Park (Figure 6). It has the same qualities as Bonner gravelly silt loam, but is always found on flat slopes. Bonner silt loam supports the western hemlock habitat type (see Habitat Types). The soil is suitable for recreation and building development, but becomes dusty if plant cover is removed from the area. Seepage from septic tank absorption fields can result in the contamination of ground water and promote frost heaving. In addition, the high content of volcanic ash make this soil type highly susceptible to compaction, which affects construction and logging operations (Weisel 1980).

C. DYSTROCHREPTIC ARENTS

Dystrochreptic arents composes 1,322 acres of Farragut State Park (Figure 6). The soil type is composed of well-drained and human disturbed soils on glacial outwash terraces. Once this soil was a Bonner silt loam, until activities by the U. S. Navy stripped the surface soil and thoroughly mixed the remaining soil. Patches of Bonner gravelly silt loam are mixed within the large dystrochreptic arents soil patch. Dystrochreptic arents supports a Douglas-fir habitat type association. It is unclear whether the habitat type can be broken down into phases, due to the area being in an early stage of succession. The soil is suitable for wildlife habitat, recreation use, and building. The vegetation provides habitat for white-tailed deer, black bear, elk, small mammals, songbirds, and raptors. Small stones and the slope of steeper areas limit recreational development. The soil is suited for septic tank absorption fields and does pose a hazard to ground water pollution (Weisel 1980).

D. KOOTENAI COBBLY SILT LOAM

Farragut State Park consists of 297 acres of Kootenai cobbly silt loam (Figure 6). It is on 0-7% slopes. The soil is very deep, well drained, and formed in slightly weathered glacial till modified by water and mantled by loess and volcanic ash. Kootenai soils are on glacial outwash plains, terraces and recessional moraines. Soil permeability is moderate, while available water capacity is low (4-6 inches) for both soils. Water runoff is slow to medium and soil erosion is slight to medium. The Kootenai soil supports a Douglas-fir / ninebark habitat type. The restoration and maintenance of old-growth ponderosa pine with timber harvesting and prescribed fire is required on the Kootenai soils. Managers need to account for water erosion and slope during timber harvest operations. Conventional harvest systems require careful planning inorder to minimize soil loss. Roads and landings can be protected from erosion by seeding road cuts and fills and by building water bars. Native species which need to be maintained on the Kootenai soil type are bluebunch wheatgrass (*Agropyron spicatum*), elk sedge (*Carex geyeri*), pinegrass (*Calamagrostis rubescens*), snowberry (*Symphoricarpos albus*), spiraea (*Spiraea betulifolia*), western fescue (*Festuca occidentalis*), roses (*Rosa* species), and strawberries (*Fragaria* species). The re-introduction of fire will maintain and add vigor to these plant species. Maintainence of the understory plant layer will minimize erosion on the Kootenai soils. The native vegetation provides habitat for white-tailed deer, black bear, elk, songbirds, small mammals, and grouse. Recreation, structure, and road development are limited by rapid soil permeability, large surface stones, and frost action. Community sewage systems need to be constructed in areas with high population density to prevent ground water pollution. Buildings and structures are limited in some places by large surface stones. Road designs need to consider the depth of frost penetration (Weisel 1980).

E. KOOTENAI GRAVELLY SILT LOAM

Kootenai gravelly silt loam soils composes 406 acres of Farragut State Park (Figure 6). It occurs on 20-45% slopes. The soil is very deep, well drained, and formed in slightly weathered glacial till modified by water and mantled by loess and volcanic ash. Kootenai soils are on outwash terraces and escarpments. Soil permeability is moderate, while available water capacity is low (4-6 inches) for both soils. Water runoff is very rapid and soil erosion is very high. The Kootenai soil supports a Douglas-fir / ninebark habitat type. The restoration and maintenance of old-growth ponderosa pine with timber harvesting and prescribed fire is required on the Kootenai soils. Managers need to account for water erosion and slope during timber harvest operations. Conventional harvest systems require careful planning inorder to minimize soil loss. Yarding harvest systems may be required on slopes > 35%. Roads and landings can be protected from erosion by seeding road cuts and fills and by building water bars. Native species which need to be maintained on the Kootenai soil type are bluebunch wheatgrass (*Agropyron spicatum*), elk sedge (*Carex geyeri*), pinegrass (*Calamagrostis rubescens*), snowberry (*Symphoricarpos albus*), spiraea (*Spiraea betulifolia*), western fescue (*Festuca occidentalis*), roses (*Rosa* species), and strawberries (*Fragaria* species). The re-introduction of fire will maintain and add vigor to these plant species. Maintainence of the understory plant layer will minimize erosion on the Kootenai soils. The native vegetation provides habitat for white-tailed deer, black bear, elk, songbirds, small mammals, and grouse. Recreation, structure, and road development are limited by slope, rapid soil permeability, small stones, and frost action. Paths and trails that are constructed need to extend across the slope. Community sewage systems need to be constructed in areas with high population density to prevent ground water pollution. Road designs need to consider the depth of frost penetration (Weisel 1980).

F. KOOTENAI-BONNER COMPLEX

Farragut State Park consists of 64 acres of the Kootenai – Bonner complex (Figure 6). It occurs on level to moderately steep slopes. The soils are on hummocky glacial outwash plains, terraces, and recessional moraines. Kootenai gravelly silt loam (60%) and Bonner gravelly silt loam (30%) cover 90% of the area. Avonville gravelly silt loam composes the remaining 10% of the area. Kootenai soil is very deep, well drained, and on 0-20% slopes. It is formed in slightly weathered glacial till modified by water and mantled by loess and volcanic ash. The Bonner soil is very deep, well drained, and on 0-8% slopes. It is formed in glacial outwash and mantled with loess and volcanic ash. Soil permeability is moderate to rapid for the Kootenai soil and rapid for the Bonner soil. Available water capacity is low (4-6 inches) for both soils. Water runoff and erosion is the highest on the Kootenai soil and decreases on the Bonner soil. The Kootenai soil supports a Douglas-fir / ninebark habitat type, while the Bonner soil supports a grand fir / queenscup beadlily habitat type. The restoration and maintenance of old-growth ponderosa pine with timber harvesting and prescribed fire is required on the Kootenai soils. Managers need to account for water erosion and slope during timber harvest operations. Roads and landings can be protected from erosion by seeding road cuts and fills and by building water bars. Native species which need to be maintained on the Kootenai soil type are bluebunch wheatgrass (*Agropyron spicatum*), elk sedge (*Carex geyeri*), pinegrass (*Calamagrostis rubescens*), snowberry (*Symphoricarpos albus*), spiraea (*Spiraea betulifolia*), western fescue (*Festuca occidentalis*), roses (*Rosa* species), and strawberries (*Fragaria* species). The re-introduction of fire will maintain and add vigor to these plant species. Maintainence of the understory plant layer will minimize erosion on the Kootenai soils. The native vegetation provides habitat for white-tailed deer, black bear, elk, songbirds, small mammals, and grouse. The Ardenvoir soil is suitable for the restoration of western white pine. Recreation, structure, and road development are limited by slope, rapid soil permeability, small stones, and frost action. Paths and trails that are constructed need to extend across the slope. Community sewage systems need to be constructed in areas with high population density to prevent ground water pollution. Road designs need to consider the depth of frost penetration (Weisel 1980).

G. RATHDRUM-BONNER COMPLEX

Rathdrum – Bonner complex composes 54 acres of Farragut State Park (Figure 6). It occurs on 0-7% slopes. The soils are on glacial outwash plains and terraces in depressional areas. Rathdrum silt loam (55%) and Bonner silt loam (35%) cover 90% of the area. Avonville fine gravelly silt loam and Kootenai gravelly silt loam compose the remaining 10% of the area. Rathdrum soil is very deep, well drained, and formed in deep volcanic ash and loess over glacial outwash materials. The Bonner soil is very deep, well drained, and formed in glacial outwash mantled with loess and volcanic ash. Soil permeability is moderate for both soils. Available water capacity is high in the Rathdrum soil, but low (4-6 inches) for the Bonner soil. Water runoff is slow to medium and erosion is slight to moderate for both soils. The Rathdrum soil supports a western redcedar / queenscup beadlily habitat type, while the Bonner soil supports a grand fir / queenscup beadlily habitat type. The native vegetation provides habitat for white-tailed deer, black bear, elk, songbirds, small mammals, and grouse. The Rathdrum soil is suitable for the restoration of western white pine. The soils are suited for recreation activities, but can become dusty during the dry summer months. Damage by frost action does threaten roads built over these soils. Road designs need to consider the depth of frost penetration (Weisel 1980). Most sanitary facilities can be built on Rathdrum soils, but Bonner soils are suited for septic tank absorption fields. Ground water pollution is a hazard on the Bonner soils. In addition sewage lagoons and sanitary landfills are limited by rapid soil permeability and seepage hazards (Weisel 1980).

H. VASSER SILT LOAM

Farragut State Park consists of 41 acres of Vasser silt loam (Figure 6). It occurs on 5-65% slopes. The soil is very deep, well drained, and formed in weathered granite, gneiss, and schist. It has a mixture of loess and volcanic ash in the upper soil profile. Vasser soils are found on mountains. Soil permeability is moderate and available water capacity is moderate (4-6 inches). Water runoff is rapid to very rapid and soil erosion is high to very high. The Vasser soil supports a western redcedar / queenscup beadlily habitat type. Timber harvesting is not recommended for this soil type for two reasons. 1. The forest ecosystems on this soil do not require restoration or active management. 2. The low bulk density of the surface layer makes the soil highly erodible. The construction of logging roads, skid trails, and landings would need to be carefully planned to minimize erosion. Logging on slopes > 35% may require a yarding or tractor-mounted skidding winch harvest system. The native vegetation provides habitat for white-tailed deer, black bear, elk, songbirds, small mammals, and grouse. Structures, roads, and trails are limited by slope. Paths and trails that are constructed need to extend across the slope. Frost action can be damaging to roads, so road designs need to consider the depth of frost penetration. Rapid soil permeability and seepage hazards limit the development of sanitary facilities (Weisel 1980).

III. LAKE PEND ORIELLE

A. HYDROGRAPHY AND WATER QUALITY

Lake Pend Orielle is 44 miles in length from Buttonhook Bay to Dover, ID. The maximum width of the lake is 6.25 miles. Historically, its shoreline was 112 to 116 miles. After the Albini Dam was built in 1952, the shoreline changed to 193 miles. The area of the historic lake was 123 to 130 sq. miles, while the current reservoir is 148 sq. miles. It is one of the deepest lakes in the U. S. and has a depth of 1,152 ft. Fluctuations in the water level vary around 10 ft. Flood control is the source of these fluctuations in water level. The Clark Fork River flows into Lake Pend Orielle and the Pend Orielle River flows out of the lake. Water quality of the lake is high. Local turbidity is associated with shore erosion and spring runoff adds sediment to the north end of the lake.

B. FISH

Yellow perch (*Perca flavescens*), kokanee salmon (*Oncorhynchus nerka*), Gerrard rainbow trout (*Salmo gairdneri*), brown trout (*Salmo trutta*), westslope cutthroat trout (*Oncorhynchus clarki lewisi*), lake trout (*Salvelinus namaycush*), lake whitefish (*Coregonus clupeaformis*), mountain whitefish (*Prosopium williamsoni*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), pumpkinseed sunfish (*Lepomis gibbosus*), and bullhead (*Ictalurus* species) exist within Lake Pend Orielle. Kokanee salmon and Kamloops trout are the most abundant. Kokanee migrated into Pend Orielle from the Flathead River Drainage Basin (Flathead and Clark Fork Rivers). The Kokanee population became so large that the Kamloops trout from British Columbia was introduced to the lake as a predator in 1942. Both fish are still the most abundant to date (ORB 975).

IV. VEGETATION

The vegetation in Farragut State Park consists of western redcedar, grand fir, lodgepole pine, ponderosa pine, Douglas-fir, saplings, grass, and spotted knapweed. Dry forest community types are along Lake Pend Orielle on the northeast section of the park. The center of the park consists of grass and knapweed meadows created from the Farragut Naval Training Station. Natural tree regeneration exists in the transition zone between forest and meadow. Wet forests occur in the southern and western sections of Farragut State Park (Figure 7). Farragut State Park has is diverse in plant species. In 1996, 50 forb, 6 graminoid, 2 fern, 1 noxious weed, 4 low shrub, 9 tall shrub, and 8 tree species surveyed within Farragut State Park (Appendix A). Due to multiple habitat types present, the park has the potential to support 153 forb, 19 graminoid, 6 fern, 7 noxious weed, 8 low shrub, 34 tall shrub, and 13 tree species (Cooper 1991, Appendix A). Farragut State Park also has two sensitive plant species: least bladdery milkvetch (*Astragalus microcystis*) and black snakeroot (*Sanicula marilandica*). Spotted knapweed, a noxious weed, is also present in the park. Fortunately, it is the only noxious weed observed in the most recent vegetation survey. Thirteen other weeds have been sited in Kootenai and adjacent counties and have the potential to establish in the park.

A. PLANT COMMUNITY TYPES AND HABITAT TYPES

Community types are a homogeneous assemblage of plant species occurring in a defined area. Community types are based on dominant overstory tree species and forest cover. The community type map was delineated from aerial photographs (1:15840) provided by the Idaho Department of Lands. Community types were delineated by texture, tone, crown shape, and canopy coverage (Tomar and Maslekar 1974). Farragut State Park has eight community types (Table 1; Figure 7).

Plant community types are composed of several different habitat types. The habitat types are based on potential climax vegetation. Climax is the culminating stage in plant succession for a given habitat type. Plant communities become climax with the absence of disturbances. However, the vast majority of land area included in any one-habitat type is recovering from disturbance and thus occupied by seral plant communities. Seral communities are the vegetation stages, which are replaced by other vegetation stages as succession occurs and exists before the climax stage (Cooper et al. 1991).

Table 1. Community types within Farragut State Park.

Community Type	Acres
Grass / Spotted Knapweed	15*
Grass / Spotted Knapweed / Saplings	1,342*
Saplings	65
Douglas-fir / Lodgepole pine	18
Mixed conifer associated with ponderosa pine	294
Mixed conifer associated with lodgepole pine	212
Mixed conifer associated with western white pine	197
Mixed conifer dominated by grand fir	1555
Mixed conifer dominated by western redcedar	253

*Note: The Park has actively sprayed approximately 100 acres with Tordon, so a pure grass community type does exist, but was not detected with aerial photos. It is combined with the grass / spotted knapweed and grass / spotted knapweed / sapling community types.

Three levels classify habitat types: series, association, and phase. The series level is connoted by first portion of the name identifying the potential climax tree species. Association refers to a dominant or indicator undergrowth species. Phase represents a difference in vegetation dominance in a third layer, a broad transition between two adjacent habitat types, or minor floristic variations within the habitat type. The habitat type system is a site or land classification system that employs the plant community as an integrated bioassay of environmental factors as they effect species reproduction and competitive effects. Useful attributes of the habitat type classification system are (Cooper et al. 1991):

1. They provide a permanent and ecologically based system of land stratification referenced to vegetation potential.

2. The system furnishes a vegetation classification system for mature to near-climax forest communities.

3. They serve as a system useful for succession modeling.

4. The units of land within the same type can expect similar succession responses to management treatments or disturbances.

Farragut State Park has six habitat type combinations and an unknown habitat type (Table 2; Figure 8). A description of each habitat type is provided in this section of the Farragut State Park management plan (Cooper et al. 1991). Daubenmire and Daubenmire (1968) developed the first habitat type system for the forests of northern Idaho. In 1991, Cooper, Neiman, and Roberts (Cooper et al. 1991) revised the Daubenmire forest habitat type system. Further habitat type descriptions can be found in these publications.

Table 2. Habitat types of Farragut State Park

Habitat Type	Acres
Unknown	11
Douglas-fir	1,302
Douglas-fir / ninebark	483
Douglas-fir / ninebark & grand fir / twinflower	64
Douglas-fir / ninebark & grand fir / queenscup beadlily	41
Grand fir / queenscup beadlily & grand fir / twinflower & grand fir / ninebark	387
Grand fir / queenscup beadlily & grand fir / twinflower	1,663

Douglas-fir Habitat Type

Dystrochreptic arents soil was created with the establishment of the Farragut Naval Training Station and supports a Douglas-fir habitat type series with no phases. Before the Farragut Naval Station was established, the area consisted of Bonner soils and was associated with a grand fir habitat type. It is unknown whether a grand fir habitat will exist again in this disturbed area (Figure 8).

Douglas-fir / Ninebark (PSME / PHMA) Habitat Type

The Douglas-fir / ninebark habitat type is the most widely occurring Douglas-fir habitat type in northern Idaho. The habitat type occurs on southeast to west aspects and on low to moderate slopes (Figure 8). It is at elevations of 2,000 to 3,700 ft. The habitat type exists in two phases: starry Solomon's seal (*Smilacina stellata*) and ninebark (*Physocarpus malvaceus*). Both phases exist within Farragut State Park (Daubenmire and Daubenmire 1968, Cooper et al 1991).

The starry Solomon's seal phase occurs throughout the PSME / PHMA habitat type. Douglas-fir is the climax dominant. Western larch and ponderosa pine are dominants in late seral forests. The habitat type has a frequent fire regime, which maintains western larch and ponderosa pine as codominants. Diagnostic indicators for this phase are the presence of starry Solomon's seal, Hooker fairy-bell (*Disporum hookeri*), northern bedstraw (*Galium triflorum*), or > 10 trees per acre of western larch. The phase has more mesophytic species then the ninebark phase. These species include mountain sweet cicely (*Osmorhiza chilensis*), windflower (*Anemone piperi*), western meadowrue (*Thalictrum occidentale*), and bigleaf sandwort (*Arenaria macrophylla*). Elk sedge (*Carex geyeri*) and pinegrass (*Calamagrostis rubescens*) can form sod in seral forests but are sparse under mature canopies.

The ninebark phase represents dry and warm sites. Ponderosa pine is the major seral species while western larch sometimes occurs as an accidental. Douglas-fir is a climax species within the phase. The habitat type has a frequent fire regime, which maintains ponderosa pine as the dominant species. The diagnostic indicator for the ninebark phase is the lack of diagnostic species from the starry Solomon's seal phase. Elk sedge and pinegrass dominate some sites. However the dominant understory plants are moderate to tall shrubs and dry-site forbs.

The habitat type in a seral stage provides abundant food and cover for big game. Parent soil materials are basalt and quartzite for the starry Solomon's seal phase, while the ninebark phase has granitics, loess, and volcanic ash for parent material. The starry Solomon's seal phase has silt-loam to silty clay-loam textures. The ninebark phase consists of gravelly sandy loam to clay-loam textures (Daubenmire and Daubenmire 1968, Cooper et al 1991).

Grand Fir / Ninebark Habitat Type

The grand fir / ninebark habitat type is a minor habitat type with a broad distribution throughout northern Idaho (Figure 8). The habitat type exists in two phases: western goldthread (*Coptis occidentalis*) and ninebark. Both phases exist within Farragut State Park (Daubenmire and Daubenmire 1968, Cooper et al 1991).

Western Goldthread Phase

The phase is on moister and cooler sites within the grand fir habitat types. The elevation range is from 2,200 to 4,300 ft. Grand fir is near its environmental limits within this habitat type. The habitat type has a frequent fire regime, which further reduces grand fir. Douglas-fir and ponderosa pine are seral species within this habitat type. Solomon's seal, Hooker fairy-bell (*Disporum hookeri*), and western swordfern (*Polystichum munitum*) dominate this phase. Burning within the habitat type increases abundance of *Ceanothus* species and bracken fern (*Pteridium aquilinum*).

Ninebark Phase

It is one of the driest grand fir habitat types and occupies southeast through west slopes, except at low elevations. The elevation range is from 2,200 to 4,300 ft. Grand fir, western larch, lodgepole pine, and western white pine are near their environmental limits within this habitat type. The habitat type has a frequent fire regime, which further reduces grand fir. Douglas-fir and ponderosa pine are seral species within this habitat type. Tall shrubs of ninebark, oceanspray (*Holodiscus discolor*), and Rocky Mountain maple (*Acer glabrum*) dominate the phase. Other important shrubs, which decline with forest age, are serviceberry

(*Amelanchier alnifolia*), snowberry (*Symphoricarpos albus*), and creeping Oregon grape (*Berberis repens*). Dominant forbs are starry Solomon's seal, mountain sweet cicely, northern bedstraw, windflower (*Anemone piperi*), trail-plant (*Adenocaulon bicolor*), Columbia brome (*Bromus vulgaris*), and pinegrass. Burning within the habitat type increases abundance of *Ceanothus* species and bracken fern (*Pteridium aquilinum*).

The habitat type provides important winter range, thermal cover and hiding cover for deer and elk. Parent soil materials are granite, mica shist, rhyolite, quartzite, argillite, and basalt. Some profiles are loess influenced, while ash layers are common. Soil textures are loams and silt loams (Daubenmire and Daubenmire 1968; Cooper et al 1991).

Grand Fir / Twinflower Habitat Type

The grand fir / twinflower (ABGR / CLUN) habitat type is a minor habitat type and is actually more extensive in central Idaho. The habitat is found on protected and gentle slopes and benches (Figure 8). Soils are gravelly depositional soils that are slightly acidic and with shallow ash horizons. The habitat type exists in two phases: twinflower and beargrass (*Xerophyllum tenax*). The twinflower phase is the only phase within Farragut State Park (Daubenmire and Daubenmire 1968, Cooper et al 1991). The phase is associated with coarse outwash materials. Douglas-fir and ponderosa pine are the dominant seral species. Other seral species within early succession stages of the habitat type are lodgepole pine, Engelmann spruce, ponderosa pine, and western larch. Twinfower is common to abundant and pinegrass forms a scattered herb layer. Pinegrass dominates early succession stages and declines with succession. Its cover is reduced by crown closure in mature forest patches. The early stages of succession provide forage for wildlife (Daubenmire and Daubenmire 1968; Cooper et al 1991).

Grand Fir / Queenscup Beadlily Habitat Type

The grand fir / queenscup beadlily (ABGR / CLUN) habitat type is broadly distributed throughout northern Idaho (Figure 8). The habitat type exists in five phases: fool's huckleberry (*Menziesia ferruginea*), Pacific yew (*Taxus brevifolia*), beargrass, ninebark, and queenscup beadlily (*Clintonia uniflora*). The ninebark and queenscup beadlily phases are the only phases within Farragut State Park (Daubenmire and Daubenmire 1968, Cooper et al 1991).

Ninebark Phase

The ninebark phase occupies the warmest and driest portion of the habitat type. The elevation range is from 2,200 to 4,800 ft. It occurs on east- to west-facing slopes and predominates south-facing slopes. Douglas-fir is the dominant seral species. Other seral species within the early succession stages of the habitat type are western larch, lodgepole pine, and ponderosa pine. Grand fir dominates mid- to late-seral forests and climax forests. The phase is dominated by a high coverage of ninebark and oceanspray, Rocky Mountain maple, serviceberry, baldhip rose (*Rosa gymnocarpa*), snowberry, and western thimbleberry (*Rubus parviflorus*).

Queenscup Beadlily Phase

The queenscup beadlily phase occupies an elevation range of 2,200 to 5,350 ft. It occurs on warm exposures, drained sites, benches, stream terraces, toe-slope to midslope positions, low to moderate slopes, and all but northerly aspects. Douglas-fir and grand fir are the dominant seral species. Other seral species within the early succession stages of the habitat type are western larch, lodgepole pine, ponderosa pine, western white pine, and Engelmann spruce. Grand fir dominates climax forests. Twinflower is common and dominant on benches and toe-slopes, while blue huckleberry (*Vaccinium globulare*) occurs on cooler exposures. Western goldthread, starry Solomon's seal, and queenscup beadlily dominate the forb layer.

All phases produce abundant winter forage for elk and deer. Parent soil materials are wide and include limestone. Ash is rare on the queenscup beadlily phase, but present on the other phases. Soil textures are loams, silt-loams, clays, and loamy sands (Daubenmire and Daubenmire 1968; Cooper et al 1991).

Detailed descriptions for each habitat type can be found in Forest Habitat Types of Northern Idaho: A Second Approximation (Cooper et al. 1991).

B. PLANT DIVERSITY AND SENSITIVE PLANT SPECIES

Farragut State Park is diverse in plant species. In 1996, 50 forb, 6 graminoid, 2 fern, 1 noxious weed, 4 low shrub, 9 tall shrub, and 8 tree species were surveyed with Farragut State Park (Appendix A). Due to multiple habitat types present, the park has the potential to support 153 forb, 19 graminoid, 6 fern, 7 noxious weed, 8 low shrub, 34 tall shrub, and 13 tree species (Cooper et al. 1991, Appendix A). The Conservation Data Center (1994) found two sensitive plant species in Farragut State Park (Figure 9): least bladdery milkvetch (*Astragalus microcystis*) and black snakeroot (*Sanicula marilandica*). The 1996 survey did not find these species.

Least bladdery milkvetch is found in open prairies, foothills and ponderosa pine forests. Its distribution is from northeast Washington and British Columbia across the Idaho panhandle to western Montana. *Astragalus microcystis* has the following status:

CDC Global Rank: G5 = Demonstrably widespread, abundant, and secure.

CDC State Rank: SH = Historical occurrence (i.e., formerly part of the native biota with the implied expectation that it might be rediscovered).

Idaho Native Plant Society: 1 = STATE PRIORITY 1. Taxa in danger of becoming extinct or extirpated from Idaho in the foreseeable future if identifiable factors contributing to their decline continue to operate; these are taxa whose populations are present only at critically low levels or whose habitats have been degraded or depleted to a significant degree.

Federal: None

USFS, Region 1: None

USFS, Region 4: None

BLM: None

Black snakeroot has a wide range on the East Coast from Newfoundland to Florida. It also appears east of the Cascades on moist lowlands to damp wooded slopes. It is distributed from British Columbia, northern Idaho, northeast Washington, southwest Montana, and the southern Rocky Mountains. The plant is seldom < 4 dm in height. It has a cluster of fibrous roots from a single caudex or crown. The Flambeau Ojibwe tribe pounded the root into a poultice to cure rattlesnake and snake bites. If the root were chewed, it would cause eruptions on the epithelial lining of the mouth, which was considered a very potent remedy. The root is also reported to contain resin and volatile oil, which is allegedly successful in treating intermittent fever and cholera. Some Indians used it to treat syphilis and diseases of the lung. The leaves are deeply lobed and often palmately compound. The 5-7 dentate leaflets are sharply toothed. The flowers are greenish white. *Sanicula marilandica* has the following status:

CDC Global Rank: G5 = Demonstrably widespread, abundant, and secure.

CDC State Rank: S2 = Imperiled because of rarity or because other factors make it very vulnerable to extinction (typically 6 to 20 occurrences).

Idaho Native Plant Society: S = SENSITIVE. Taxa with small populations or localized distributions within Idaho that presently do not meet the criteria for classification as Priority 1 or 2 but whose populations and habitats might be jeopardized without active management or removal of threats.

Federal: None

USFS, Region 1: S = SENSITIVE SPECIES (S). Taxa that are identified by the Regional Forester for which viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

USFS, Region 4: None

BLM: None

C. PACIFIC PONDEROSA PINE (*Pinus ponderosa var. ponderosa*)

Farragut State Park has 294 acres of ponderosa pine forest (Figure 7). Pacific ponderosa pine is dependent on elevation, soil texture, soil depth, availability of nutrients, climate, and soil moisture for its distribution (Daubenmire and Daubenmire 1968). In Idaho, it grows on all aspects and slopes and is distributed from 1,000-6,000 ft in elevation (Wright and Bailey 1982, Oliver and Ryker 1990, Fire Effects Information System 1996a). Ponderosa pine is typically found on warm, dry sites, in areas with a short growing season and minimal summer precipitation. Ponderosa pine soils consist of glacial tills, glacio-fluvial sands and gravels, dunes, basaltic rubble, colluvium, deep loess soils, and volcanic ash. Soil textures consist of sands to clay loams and occassionally clays. Ponderosa pine grows best on medium-textured soils (loam soils, moderately sandy soils or gravelly soils). In northern Idaho, the mean annual precipitation within the ponderosa pine and Douglas-fir (*Pseudotsuga menziesii*) zones varies from 15-30 inches per year. The majority of this precipitation is provided in the form of snow during the winter season. The summer season typically has < 1 inch per month of rainfall (Krajina 1965, Daubenmire and Daubenmire 1968, Wright and Bailey 1982, Oliver and Ryker 1990). Soil moisture is the factor that most often limits growth, especially in summer when rainfall is low. However, ponderosa pine is a superior competitor in relation to other tree species in obtaining its nutritional and water needs from these soils (Wright and Bailey 1982, Oliver and Ryker 1990, Fire Effects Information System 1996a).

Pacific ponderosa pine grows in several habitat types in northern Idaho. It is a climax species in 3 associations of the Douglas-fir series and 4 associations of the ponderosa pine series in northern Idaho. It is a major seral species in 5 associations of the grand fir (*Abies grandis*) series and 7 associations of the Douglas-fir series. Ponderosa pine is also a minor seral species in 9 associations of the western redcedar (*Thuja plicata*), grand fir and Douglas-fir series (Wright & Bailey 1982, Cooper et al. 1991, Fire Effects Information System 1996a). Farragut State Park has the following ponderosa pine habitat types (Figure 8):

- Douglas-fir / Ninebark
- Grand fir / Ninebark

The Douglas-fir / ninebark and grand fir / ninebark habitat types dominate the eastern end of the park around Lake Pend Orielle and next to Bayview, ID. Moving westward, these habitat types relinquish dominance to the mesic grand fir habitat types (Figure 8).

Ponderosa Pine Ecosystem

Ponderosa pine (*Pinus ponderosa*) is a topo-edaphic climax species (Daubenmire and Daubenmire 1968) in dry coniferous forests and late seral species in more mesic coniferous forests. Low soil moisture in climax ponderosa pine forests and frequent surface fires in seral ponderosa pine forests prevents the establishment of Douglas-fir (*Pseudotsuga mensiezii*), grand fir (*Abies grandis*) and other competitive species.

Frequent, non-lethal surface fires historically occurred in Idaho's ponderosa pine forests and prevented Douglas-fir and grand fir encroachment. Logging in the early part of the 20th century made it impossible to sample the fire history of Farragut State Park. However, it is believed that the fire interval is similar to data taken from surrounding studies. Weaver (1959, 1967) found a mean fire interval of 6-47 years in eastern Washington and northern Idaho ponderosa pine forests. In the Palouse region of Idaho, Osborne (1997) measured a mean fire interval of 7.8 years at the University of Idaho Experimental Forest. Brown et. al. (1994) found a mean fire interval of 23 years in the Selway-Bitterroot Wilderness. Finally, Harkins and Neuenschwander (1997) found a fire interval of 13-20 years at Heyburn State Park.

In Idaho, frequent wildfires in ponderosa pine forests enable seral ponderosa pine and the occassional Douglas-fir to develop into open multi-aged forest patches. Low to moderate intensity surface fires kill most understory trees and occassionally groups of overstory trees (Steele et al. 1986, Arno et al. 1995a). Douglas-fir that survive these fires do not live long due to decay hastened by fire injury (Arno et al. 1995b). Lethal surface and crown fires also occurred in moist ponderosa pine forests. These fires occur because of unusual fire weather and longer than normal fire intervals that allow litter and understory fuels to accumulate (Steele et al. 1986, Arno et al. 1995a). Cooper (1960) examined the extent of these burns and found a wide age-class range across 5-10 acre plots. He determined that periodic tree establishment at a small scale occurred in ponderosa pine forests. Cooper found that mature forest patches had a variable clump size of 0.49-1.05 acres, and seedling and sapling patches had a clump size of 0.49-2.11 acres. Between the patches with lethal fire behavior, low intensity surface fires occurred at a rate of 3 to 4 per century and maintained the open ponderosa pine forests (Weaver 1959, Weaver 1967, Kilgore and Curtis 1987, Arno 1988, Barrett 1988, Arno et al. 1995b, Steele and Geier-Hayes 1995).

In addition to periodic fires, bark beetle attacks helped control the density, age classes, and composition of historic ponderosa pine communities. Bark beetle epidemics occur in forests when tree recruitment exceeds mortality and stand basal area exceeds sustainable levels (Steele and Geier-Hayes 1995). When old individual trees or groups of trees are weakened by drought(s) they may be attacked by insects. Western pine beetle (*Dendroctonus brevicomis*) attacks and kills single trees or groups of trees. Trees killed by beetles add to this uneven-aged patch mosaic (Agee 1993). Surface fires also occasionlly weaken and kill the large ponderosa pine trees. Fire scars a tree and creates a wound that may eventually become infected with stem decay. Stem rots create "punky" material in the scar and the next fire ignites this material (Agee 1993, Arno et al. 1995b). Repeated fires burn the tree in half. Fire damaged trees are more susceptible to western pine beetle, mountain pine beetle (*Dendroctonus ponderosae*), red turpentine beetle (*Dendroctonus valens*), and pine engraver beetles (*Ips* species) attacks (Agee 1993). Whether beetles kill trees depends on the interaction of fire damage, drought, tree vigor, and the magnitude of beetle infestation.

With the appropriate climate and seed crops, openings in the forest canopy created by tree mortality may be suitable for seedling germination. Competition for moisture with grass, shrubs and other trees can limit reproduction in these openings (Agee 1993). Frequent fires will remove competitors from reproduction areas, but can also aid in the growth and flowering of grasses and forbs. Competition from grass limits tree regeneration to fire scarified areas (Agee 1993). Once seedlings establish and mature, they are protected from fire for a few years because of the lack of fuel on the forest floor and the elimination of small trees under the mature forest canopy. Eventually fuels accumulate under these young trees and the next fire eventually thins them. Subsequent wildfires sweep through these canopy openings and consume logs, kill seedlings, and thin saplings. Variable spacing results from a combination of thinning with fire and competition for moisture. Young pine forest patches still continue to grow and underburn at frequent intervals. Tree mortality resulting from these fires decline with height and diameter growth (Agee 1993). Upon reaching the mature old-growth ages, trees are still susceptible to beetles and eventually succumb to insect attack (Weaver 1943). This pattern repeats through time and results in large within-group age classes (Agee 1993). Cooper (1960) suggests that old forest patches impacted by disturbances experience a rapid breakup in 20 years or less. Breakups are possibly associated with insects, disease, and drought. White (1985) surveyed a ponderosa pine forest in northern Arizona and found significant differences from Cooper's rapid clump breakup and regeneration hypothesis. He suggests that in some cases the whole forest patch may not die simultaneously, but instead one or two trees might die and add to the fuel load. Frequent fires consume this down woody debris and provide limited regeneration sites. Repetition of this pattern over time would result in within group age ranges within the old-growth patch. Drought in 1994 and abnormally wet weather, high winds, ice storms, and root rots during 1995, 1996 and 1997 caused bark beetle epidemics in Heyburn State Park from 1996-1998. Stressed young Douglas-fir were attacked and killed by Douglas-fir beetle (*Dendroctonus pseudotsugae*) and Douglas-fir pole beetle (*Pseudohylesinus nebulosus*). Many of the dead trees fell down and generated dense slash piles on the forest floor. The slash from these dead trees provided habitat for western pine beetle, which later infested large diameter ponderosa pine trees. Ponderosa pine mortality within the park at that time consisted of a single dead tree to clumps of 4-5 dead trees. These observations correspond with White's hypothesis. A similar event is possible in Farragut State Park due to forest density.

Fire Exclusion and Historical Management Practices

New, multi-layered forests of dense Douglas-fir (*Pseudotsuga mensiezii*), grand fir (*Abies grandis*) and ponderosa pine (*Pinus ponderosa*) are the result of fire suppression, exploitive logging practices, domestic livestock grazing and relocation of native Americans (van Wagtendonk 1985, Arno and Brown 1991). These events disrupted the historic fire regimes in ponderosa pine forests. Ponderosa pine forests experienced frequent low to moderate intensity fires prior to the 1900's. The removal of native Americans to reservations reduced the yearly ignitions within these forests. Past logging activities selectively removed the large ponderosa pines and the small openings created by the removal of these large trees filled in with dense patches of saplings. Unregulated livestock grazing became widespread in the late 1800's and grasses and other light fuels needed for ignition and initial spread of fire were removed from the area.

The combination of these factors (fire suppression, exploitive logging, domestic livestock grazing, and native American relocation) created dense ponderosa pine forest landscapes characterized by increased levels of dying trees, insect and disease epidemics, forest floor fuel accumulations and catastrophic wildfires. Wildfires in these dense ponderosa pine forests do not follow the historical fire regime. They are larger in extent, intensity, and severity (Covington and Moore 1994, Arno et al. 1995a). Drought interacting with dense ponderosa pine forests is a major factor causing catastrophic fires throughout this century. However, even in presettlement times, severe drought in combination with high winds and ignition resulted in small wildfires, but not to the extent of recent times (Weaver 1943, Steele et al. 1986, Arno et al. 1995a).

Dense ponderosa pine forests are more vulnerable to insects, pathogens, and lethal surface and crown fires. Current forests have the same insect and pathogen associates as historical ponderosa pine forests. However, the increase in continuity of hosts across the landscape often heightens the extent, duration, and severity of damage to forest patches (Everett et al. 1994). The shift and increase in fuel continuity and loads provides more available energy and ladder fuels. Fuel buildup results in higher intensity lethal surface and crown fires in ponderosa pine ecosystems (van Wagtendonk 1985, Steele et al. 1986). The amount of ponderosa pine seed is reduced by lethal crown fires, while seed sources increase in late succession species (Arno et al. 1995b). Before 1900, the normal fire intervals maintained ponderosa pine dominance and removed Douglas-fir and grand fir regeneration. When small patches of trees are killed, ponderosa pine is the primary tree surviving along the fire perimeter and is able to seed much of the burn area (Arno et al. 1995b). Ponderosa pine seed does not travel far from parent trees, so large lethal fires limit natural regeneration by ponderosa pine. The present consumption of ponderosa pine forests by large lethal fires is occurring at a rate that never existed in the past. It has been estimated that old-growth ponderosa pine forests in Idaho have been degraded by 60-70% from fire suppression and high grade logging operations (Noss et al. 1995). The return of ponderosa pine forests to low-intensity surface fires perpetuates historic ecosystems and reverts dense ponderosa pine ecosystems to their original succession trajectory by reducing the magnitude of wildfires (van Wagtendonk 1985, Steele et al. 1986).

Parks, preserves, wilderness areas and roadless areas have also experienced changes in ponderosa pine forest structure, composition and processes due to fire exclusion (Arno et al. 1995a). Consequently, managers are reconsidering earlier attempts to create static preserves within dynamic ecosystems. Focus is now on conserving the disturbance processes of ecosystems, which is as important as conserving species and unique habitats (Everett et al. 1994). In ponderosa pine ecosystems, the dominant disturbance regime is fire. The maintainence of a nonlethal, frequent surface fire regime is a requirement for the retention of old-growth ponderosa pine ecosystems.

D. WESTERN WHITE PINE (*Pinus monticola*)

Farragut State Park has 197 acres of forest with sparsely distributed western white pine (Figure 7). Western white pine in the inland west grows between 1,500-6,000 ft elevation along moist creeks, wide river bottoms, flats, gentle lower slopes and northerly slopes. Within Idaho, these land types are best represented by the Priest, Coeur d' Alene, St. Joe, and Clearwater basins (Haig et al. 1941, Hagle et al. 1989, Graham 1990). The western white pine region in the Inland west is influenced by the prevailing westerlies which carry maritime air masses from the northern Pacific Ocean across the Northern Rockies during the winter and spring. The mean annual rainfall (Haig et al 1941) ranges from 28-50 inches. Winter and spring are characterized by gentle rains, deep snows at high elevations, cloudiness, fog and high humidity. Summers are generally dry and provide < 1 inch precipitation per month (Cooper et al. 1991). Western white pine soils are composed of loess or loess-like material (Graham 1990). These soils are shallow to deep and are able to store high amounts of water. Water storage helps western white pine survive the dry summers (Haig et al. 1941). Soils suitable for western white pine within Farragut State Park are silt loams.

Western white pine (*Pinus monticola*) grows in a variety of habitat types in northern Idaho. It is a major seral species in six phases of the western hemlock (*Tsuga heterophylla*) series, one phase of the western redcedar (*Thuja plicata*) series and one phase of the subalpine fir (*Abies lasiocarpa*) series in northern Idaho. It is also a minor seral species on 42 phases of the grand fir (*Abies grandis*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), mountain hemlock (*Tsuga mertensia*), subalpine fir (*Abies lasiocarpa*) and the lodgepole pine (*Pinus contorta*) series (Hagle et al. 1989, Cooper et al. 1991). Western redcedar / wild ginger (*Asarum caudatum*), Western redcedar / queenscup beadlily (*Clintonia uniflora*), and grand fir / queenscup beadlily are the most important habitat types that have western white pine in northern Idaho and eastern Washington (Graham 1990). Farragut State Park possess all three of these habitat types (Figure 8). Fire and white pine blister rust killed large volumes of western white pine before the development of these habitat type models. Consequently, the habitat types may represent only a portion of the original white pine forest.

History and Ecology of Western White Pine

Western white pine (*Pinus monticola*) is a seral fire-dependent species. Its survival depends on large crown wildfires, which open forest canopies and provide mineral soil for successful seed germination and establishment (Shiplett and Neuenschwander 1993). Seed dispersal for the species has been reported to range from 400-2620 ft from parent trees (Hagle et al. 1989, Graham 1990). The seeds come from unburned forest patches, the fire perimeter, areas that are lightly burned, and the surviving seeds in the crowns of burned trees (Shiplett and Neuenschwander 1993). Western white pine is a moderately shade intolerant (50% of full sunlight is a minimum for good growth and development) species (Haig et al. 1941). It grows best under full sunlight along with western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*), and Douglas-fir (*Pseudotsuga menziesii*). Western larch and lodgepole pine have the highest rate of growth and are followed by western white pine and then Douglas-fir. If western white pine is given an equal start with other conifer seedlings, it can out-compete and form a large portion of the mature overstory. The moderate shade tolerance of the species also allows it to outcompete other species and form a larger proportion of the forest composition under partial shade (Haig et al. 1941). The species remains dominant for up to 300 to 400 years with the absence of white pine blister rust (Graham 1990). Eventually it is killed by wildfire or bark beetles, and the reproduction cycle begins again. Today, young western white pine are unable to obtain dominance because of the presence of white pine blister rust (*Cronartium ribicola*).

Fire suppression, the lack of major wildfires, and white pine blister rust decreased western white pine regeneration from 44% in 1941 to 5% in 1979 (Graham 1990). The Interior Columbia River Basin Assessment (1996) determined that only 4.5% of western white pine remains and most of it is in rust-resistant plantations. Western white pine depends on disturbances to remove competitors and allow it to become established as a dominant, seral species (Graham 1990, Fire Effects Information System 1996b). The absence of lethal crown fires is allowing shade tolerant conifers to replace western white pine and assume dominance within these forests. In additon, the presence of white pine blister rust is accelerating the succession process. The rust decreases the resistance of the white pine to fire by reducing its ability to recolonize burned and logged areas. The rust attacks the young white pine seedlings and eliminates future adult western white pine trees. Ultimately, this results in succession moving forward to a climax community of shade tolerant species (Shiplett and Neuenschwander 1994).

White Pine Blister Rust (*Cronartium ribicola*) and Genetic Resistance

White pine blister rust (*Cronartium ribicola*) was introduced into this country from infected seedlings imported from France in 1910 (Haig et al. 1941, Hoff 1992). The rust requires alternate hosts of five-needled pines and currants (*Ribes* species) to complete its life cycle. The rust is annual on the leaves of currants, but perennial in the bark of western white pines. The rust produces basidiospores on currants that infect western white pines (*Pinus monticola*). These spores are transported by local and long range wind conditions during the Fall or anytime during extended cool, moist conditions (Hoff and McDonald 1980, Hoff 1992). Western white pine can be infected with spores from currants that are 1000 ft to 150 miles from the tree (Haig et al. 1941, van Arsdel 1965). The spores germinate on the secondary needles, and enter the tree through the stomatal openings. In the secondary needles, the fungus produces a large mass of mycelium. The mycelium changes the color of the pine needle cells and can be viewed as needle spots on the exterior of the needle. From the needles the mycelium grows through the tree branch and into the stem of the tree. Within the stem of the tree, the mycelium grows profusely within the cortex and phloem tissues. After the fungus completely encircles the stem, the tree will die. Death results from the disruption of the phloem and cortical tissues during the production of the aeciospore stage (Hoff and McDonald 1980). Dicaryotic aeciospores move from the western white pines to currants in the Spring and begin the process again (Hoff and McDonald 1980, Hoff 1992).

A survey on the St. Joe and Clearwater National Forests in 1937 revealed that 4% of all young white pine trees were infected by blister rust (Haig et al. 1941). Survey information on the percentage of young white pine trees infected by blister rust in the Farragut area is not present in the literature. However, the 1937 survey demonstrates how quick the rust is in attacking and killing seedlings and saplings. White pine blister rust can also infect large diameter trees. Large diameter trees may take several decades or more to die, but small diameter trees may die in just a few years (Haig et al. 1941). Weakened by the rust, large trees are more susceptible to mountain pine beetles (*Dendroctonus valens*). Bark beetles and wildfire are normal processes experienced by these forests and are essential for reproduction of the species. White pine blister rust in association with mountain bark beetle accelerates the loss of old growth white pine forests. The beetles and rust interrupt the reproduction cycle by killing mature reproducing trees (Neuenschwander et al. In Press). White pine blister rust also kills young white pine seedlings. Hence, mature trees continue to be removed by disturbances and are not replaced by new white pine forests (Neuenschwander et al. In Press). Presently, the remaining mature white pine forests do not have sufficient numbers of resistant individuals or resistence levels within individuals to adequately retain these forests (Gerhold et al. 1986).

V. FOREST FUELS

Fuel models from the Photo Guides for Appraising Downed Woody Fuels in Montana Forests: INT 96, 97, and 98 (Fischer 1981a-c) contain information that is used to appraise the dead woody debris on the forest floor. The guide is primarily for natural (no slash) fuels. Natural fuels result from wind, snow, and mechanical breakage, natural pruning of lower branches, needle fall, windthrow, blowdown, and the falling of trees killed by insects, disease, fire, and competition for light and moisture. Old logging and thinning slash shown has either been treated or left untreated and can be considered as part of the natural fuel complex. The guide is designed to help forest managers describe the deadwood on the forest floor. The fuel models can be used to plan fire management strategies including fire prevention, fuel treatment, prescribed fire, dispatching for fire suppression, and establishing criteria for unscheduled prescribed fires. The precision of these models is unknown. However, it is expected to be intermediate: less than standard fuel inventories but greater than designating a stylized fuel model such as used in the National Fire Danger Rating System. The fuel complexes are described in terms of the following characteristics: forest cover type, habitat type, stand and site data (age of overstory dominants, average slope, aspect, elevation, and fire ecology group), down and dead woody fuel loadings by size class, other fuel data (average duff depth, fuels 3 inches in diameter and greater, average diameter, percentage rotten, and the volume of sound material), National Fire Danger Rating System fuel model, and stylized fuel model.

Several important fuel characteristics can be seen in the photo for each fuel model: (1) The amount of fuel in the different diameter classes, (2) the distribution of the fuel over the area, and (3) the depth of the fuel. In certain cases, no one photo adequately represents the actual situation. Consequently, two photos that bracket the observed fuel complex can be used to interpolate between the values on the data sheets accompanying the selected photos. The fuel models contain adjective ratings for five different expressions of fire behavior: rate of spread, intensity, torching, crowning, and resistance to control. In addition, an overall fire behavior potential rating is also given for the fuel complex. The ratings are for an "average bad" fire weather situation defined as: 80 – 90 degree F temperature, 15 – 20 % relative humidity, 10 – 15 mph wind speed, and 4 weeks since a significant rain. Farragut State Park has eight fuel model combinations (figure 10).

Table 3. Fuel models within Farragut State Park.

Fuel Model	Acres
1	6
2	9
2/1/5	1,332
2/5	11
5/1	65
8	376
8/10	1,975
10	177

A. FUEL MODEL 1

Fuel model 1 represents grasslands and savannas (Figure 10). Annual and perennial grass is present. The fine, continuous herbaceous fuels control fire spread in this fuel model. These fuels are cured or nearly cured. Surface fires move rapidly through the cured grass and flammable materials. Shrub and timber fuels are sparse (< one-third of the area). Fuel model 1 has the fastest rate of spread (78 chains per hour) of all the fuel models in Farragut State Park. Flame lengths are around 4 feet (Anderson 1982).

B. FUEL MODEL 2

Open shrub lands and pine stands that cover one-third to two-thirds of the area represent fuel model 2 (Figure 10). Fire spread is through the cured or dead, fine, herbaceous fuels. Surface fires move rapidly through the herbaceous material, litter, and dead-downed stemwood. The litter and stemwood come from the shrub and timber overstory and increase fire intensity. Fuel model 2 has the second fastest rate of spread (35 chains per hour) of all the fuel models in Farragut State Park. Flame lengths are around 6 feet (Anderson 1982).

C. FUEL MODEL 5

Wildfire carries in the shrub and grass litter layer of fuel model 5 (Figure 10). Fires are not very intense, due to low fuel loads, young grasses and shrubs and little volatile fuels in the foliage. In addition, live vegetation and high moisture limit the fire behavior of fuel model 5. Fuel model 5 has a rate of spread of 18 chains per hour and a flame length of 4-ft. Under dry conditions, the rate of spread of fuel model 5 is the second fastest. Flame length remains low in comparison to the other fuel models (Anderson 1982). The moist conditions around Lake Pend Orielle limit drying conditions and wildfires within the fuel model five areas of Farragut State Park.

D. FUEL MODEL 8

Closed canopy forests that have a compact litter layer represent fuel model 8 (Figure 10). The compact layer is composed of needles, leaves, and twigs. The understory plants are sparse. Slow-burning ground fires with low flame lengths occur in this fuel model. Occasionally, the fire will encounter a heavy fuel concentration. Under severe weather conditions, heavy fuels can pose a fire hazard. Weather conditions include high temperatures, low humidity, and high winds. Fuel model 8 has a rate of spread of 1.6 chains per hour, and a flame length of 1.0 foot (Anderson 1982).

E. FUEL MODEL 10

Forests with heavy down material represent fuel model 10 (Figure 10). Fuels include large quantities of 3-inch or larger limbwood. Surface fires burn in the surface fuels with greater intensity then the other timber fuel models (8 and 9). Crowning, spotting, and torching are also more frequent. These fuels pose a fire hazard. Fuel model 10 has a rate of spread of 7.9 chains per hour and a flame length of 4.8 feet (Anderson 1982).

VI. WILDLIFE HABITAT

Three major types of wildlife habitat are available in Farragut State Park: moist coniferous forest, dry coniferous forest, and open meadows (Figure 7). These habitats provide resources for whitetail deer, mountain lion, black bear, songbirds, woodpeckers, raptors, small mammals, reptiles, amphibians and many other species. Farragut State Park provides habitat for 9 amphibians and reptiles, 114 birds, 28 small mammals, and 7 large mammals. Potentially, the park could be supporting even more species.

A. WHITE-TAIL DEER (*Odocoileus virginianus ochrourus*)

Dense coniferous forests, vegetated river bottoms, and croplands characterize whitetail deer habitat. Deer live in ponderosa pine, Douglas-fir, western redcedar / western hemlock, and Engelmann spruce / subalpine fir forests. Ponderosa pine and Douglas-fir are important winter vegetation types, while cedar / hemlock and spruce / fir forests are vital habitats in the other seasons. Other ideal habitats include large cottonwood trees with an understory of willow and herbs, shrubs and trees along rivers, and Douglas hawthorn, Saskatoon serviceberry and common snowberry in gullies and draws above rivers.

Woody plants provide adequate protein and minerals during the spring, but are below or at deer maintenance levels for the remainder of the year. The quality is low when only the twigs of deciduous species are available and when deer are forced to eat older and more fibrous plant parts. Deer prefer succulent plants to dry plants, browse leaves over twigs, and twig tips to older growth (Halls 1978). Forbs are eaten heavily in the spring and may comprise up to 50% of the deer's diet. Grasses are not a part of the diet of whitetail deer, except in late winter and early spring. During these periods, deer will eat the little green grass shoots (Halls 1978, Peek 1984). Important summer foods include redstem ceanothus, common snowberry, and forbs. In the autumn, late summer forbs drop from the diet of whitetail deer and is replaced with browse (Peek 1984). Evergreen consumption is highest in late fall and winter. Deer prefer evergreen plants to deciduous plants in the winter (Halls 1978). Evergreen and deciduous woody plants compose over half of the midwinter diet of whitetail deer in Idaho. Whitetail deer prefer the following shrub species: creeping mahonia, Saskatoon serviceberry, common snowberry, and redstem ceanothus. Bearberry, myrtle pachistima, and arboreal lichens are also in the diet of whitetail deer when they are available (Peek 1984). Whitetail deer also eat fleshy fungi, which provides them phosphorus and protein. Deer also consume fruit, which provides them with high levels of protein, phosphorus, and calcium. Fungi and fruit are not dependable sources of food because of their sporadic occurrence (Halls 1978).

Forest openings add to the variety and cover available to white-tail deer. These forest openings provide a consistent and abundant source of food and increase the amount of forest edge or accessible cover. However, these openings are only productive for a few years. Tree regeneration reduces the amount of food produced in these areas (Halls 1978). Logging and burning also creates seral plant communities that provide high quality forage for whitetail deer. These areas are used heavily if they are near suitable cover. Deer will avoid large clear-cuts and burns, due to the lack of cover. Surface fires in ponderosa pine forests provide high-preferred forage. Following a burn or cut, deer will shift to other areas during the winter. In the spring and autumn, seral shrubs in the cut or burn areas will provide excellent forage for deer (Peek 1984).

During mild winters, deer will concentrate in open areas, especially in the seral shrub communities of the western redcedar / pachistima and Douglas-fir / ninebark habitat types. Whitetail deer will concentrate in dense forests during harsh winters (Peek 1984). Forest cover provides deer with protection from extreme winter weather. Deer will concentrate in coniferous forests during periods of cold temperatures and deep snow (18 inches or 46 cm). Dense coniferous forests provide cover, but do not provide much food. Evergreen trees are seldom a major food source for whitetail deer, but provide an emergency food supply during harsh winter conditions. Western hemlock is a common emergency food source (Halls 1978). Other trees eaten by whitetail deer are Douglas-fir, western redcedar, black cottonwood, quaking aspen and ponderosa pine. Deer can cause considerable damage to seedlings when native foods are scarce in late winter and early spring. Tree seedlings are susceptible to heavy browse during this time. Heavy browsing by deer restricts vertical growth of seedlings and causes malformation and sometimes death. On pine seedlings, deer will nip the terminal bud of the seedling and reduce its vertical growth. Browsing by deer is usually not intense enough to cause pine seedling mortality (Halls 1978).

Whitetails do compete with moose and elk for forage. Moose and whitetail deer use similar summer and autumn habitats. They also seek shelter in dense conifer forests during extreme weather conditions. During the summer, whitetail and elk coexist along forest edges. In late summer, elk may eat browse forage that is used by whitetail deer as winter range. However, elk eat more grass then browse, so competition is usually not as severe (Halls 1978).

B. MOUNTAIN LION (*Felix concolor*)

Mountain lions are beneficial to wildlife populations by weeding out the weak, sick, diseased, and very old individuals. Studies in Idaho revealed that ¾ of all elk killed by mountain lions were < 1.5 years old or > 9.5 years old (Busch 1996). Mountain lions also help prevent population explosions in prey populations. The lack of predation can result in massive over-grazing in areas where the carrying capacity has been surpassed by a species (Busch 1996). The majority of a mountain lions diet consists of 60-80% mule deer (Russell 1978). In Idaho, adult mule deer bucks are eaten more often then does. Bucks prefer broken terrain at higher elevations, which is the preferred hunting ground for mountain lions (Busch 1996). Lions also spend much of the summer hunting abundant ground squirrels, then switch to deer in the winter (Busch 1996). They also eat elk, whitetail deer, moose, porcupines, beavers, marmots, mice, rabbits, bobcats, coyotes, skunks, raccoons, foxes, bear cubs, badgers, fish, grouse, insects, grasses, and berries (Russell 1978). White-tailed deer and small mammals are the most numerous prey available to mountain lions in Farragut State Park. Adult cougars kill one deer every 10-16 days in the winter and one deer every 3 weeks in the summer. Female cougars with young will feed on a deer once a week (Busch 1996). Bobcats and coyotes are frequent competitors for small mammals and deer. Bobcats, coyotes, and black bears commonly feed off of abandoned mountain lion kills (Russell 1978).

Mountain lions eat grasses to help reduce the parasites in their digestive tracts (Russell 1978, Busch 1996). Some biologists believe they also eat grass to obtain folic acid, which is an essential vitamin. Folic acid is essential for the production of hemoglobin in blood and is not available in a meat diet. Without folic acid, mountain lions become anemic (Busch 1996).

Mountain lions have varying home ranges based on their sex. In Idaho, females have an average home range of 102 mi^2, while males have an average home range of 172 mi^2 (Busch 1996). Resident male lions will not occupy the same area, while females will have overlapping home ranges (Russell 1978). The density of mountain lions in an area is limited by the presence of resident breeding males and females. If the breeding population of mountain lions is stable and no mortality occurs in that population then reproduction is suppressed in the population. The genetically dictated tolerance for interaction and space between individuals fixes the breeding population density of mountain lions. The population can increase permanently in size if environmental conditions (cover, food, and water) increase in availability (Russell 1978).

C. BLACK BEAR (*Ursus americanus*)

Selection cuts are the most highly used habitat around Farragut for black bears. Dense forests are the second most used habitat. Riparian zones are narrow and shaded by the adjacent forest canopies, so their understory contains similar forage species of adjacent plant communities. Because these habitats are small and offer similar foods, they are not used heavily by black bears (Beecham and Rohlman 1994). Clear-cuts are not popular with black bears and are avoided in all seasons. They lack cover and huckleberries. Clear-cuts are heavily scarified to increase the growth of trees. Scarification damages the rhizomes and root crowns of shrubs and reduces the amount of shrub cover in clear-cuts. Even though clear-cuts provide grasses and forbs in the spring, bears will still avoid these areas. Habitat use is also dependent on sex. Females prefer dense forests for the cover they provide. Males use roads in proportion to their availability, while females avoid roads (Beecham and Rohlman 1994). Farragut State Park provides dense forest habitat for black bears (Figure 7).

Black bears are opportunistic and make use of abundant foods. Black bears emerge from their den in early spring. They forage in uncut forest areas where trees or shrubs provide cover. Bears also forage in open forests and meadows, but do not travel far from the forest edge (Town and Mahoney 1995). Their diet consists of common horsetail, grasses, sedges, beargrass and the bulbs and aerial portions of glacier lilies and spring beauties. Bears also consume clover, dandelions, painted cup, hawkweed, and carrion during early spring. Late spring foods include succulent perennial forbs like cow parsnip, angelica, and sweet cicely (Jonkel and Cowan 1971, Beecham and Rohlman 1994, Town and Mahoney 1995). Black bears also use selection-cuts in the spring to forage on huckleberry flowers (Beecham and Rohlman 1994). Bears will also strip and eat the bark and sapwood off of 4-8 inch diameter trees. Western hemlock, western redcedar and red alder are preferred species in northern Idaho. Spring foods are abundant, but low in nutritional quality. The low quality food forces bears to live off of their body fat and they loose weight throughout the spring (Town and Mahoney 1995).

Black bears occupy shrub fields, burn areas, and selection-cuts in the fall. They occasionally use riparian zones, meadows, and avalanche chutes, but avoid clear-cuts. Selection-cuts are important and frequently used habitats due to habitat diversity, high concentrations of important bear foods, and cover. Historically, black bear habitat diversity was associated with wildfire. Fires burn in a mosaic pattern, which creates multiple bear habitats. Today, wildfire and timber harvesting that simulate historic wildfire patterns maintain habitat diversity for black bears. Wildfires create and maintain seral shrub communities by removing the forest canopy. These disturbances increase the growth and production of shrubs, which increases the abundance of black bear food. Selection-cuts also create and maintain seral shrub communities (Beecham and Rohlman 1994).

Berries become essential parts of the diet in the summer and early autumn. Berries increase the fat reserves of bears and prepare them for winter hibernation (Town and Mahoney 1995). Berries eaten by bears include huckleberry, blueberry, soapberry, red-osier dogwood, and kinnikinnik. Berries are so important to bears that Farragut State Park needs to regulate the picking of berries by visitors. Bulbs and tubers, such as glacier lily, spring beauty, Yampa, and biscuit root, are also important in early autumn. Pine nuts are also important. Late autumn foods are mountain ash at higher elevations, kinnikinnik, bulbs, carrion, and stream algae (Jonkel and Cowan 1971).

Year around foods for black bears consist of insects, honey, and carrion. Bears eat ants, beetles, bees, flies, and wasps. It is important that dead logs be left on the ground to provide habitat for these insects. Black bears are also scavengers and will eat abandoned carcasses of deer, elk, rodents, and fish (Town and Mahoney 1995). Black bears are also opportunists and will feed on human garbage. Bears will raid garbage dumpsters, trashcans, and camp and picnic sites. They will also go close to homes if pet or livestock food is left outside. People need to secure compost piles, trash, and pet and livestock foods in order to reduce black bear and human interactions (Town and Mahoney 1995).

Black bears bed in uncut forests on steep slopes. Slopes will often have a north or east aspect. A thick and patchy understory, rough topography, and few roads provide black bears with escape routes from humans and larger bears. Trees are also useful for escape. Travel corridors of cover along streams or across inhabited valleys are important for bear dispersal and movement (Jonkel and Cowan 1971, Beecham and Rohlman 1994, Town and Mahoney 1995). Selection cuts are favored over clear-cuts due to a high availability of cover (Beecham and Rohlman 1994). The availability of food in the fall determines when bears den and large quantities of fall food allow bears to remain active longer. Dens are found under tree roots, in hollow logs, brush piles, or rock caves. Denning allows black bears to survive the winter when food is scarce and weather conditions harsh (Jonkel and Cowan 1971, Town and Mahoney 1995).

The space required by bears is related to types, availability, and abundance of food. Home ranges average 6-19 mi^2 for adult females, 4-15 mi^2 for juvenile sows, and 18-60 mi^2 for juvenile and adult males. Home ranges can be as small as 1 $mile^2$ if food is abundant (Jonkel and Cowan 1971, Town and Mahoney 1995).

D. BIRDS

Farragut State Park has four main bird habitats: disturbed meadows, dry coniferous forests, moist coniferous forests, and human use areas (Figure 7). These bird habitats provide resources for raptors, owls, upland game birds, passerines and waterfowl. Potential bird species that may use these habitats are listed in Appendix A. Farragut State Park also provides habitat for bald eagles (listed as endangered in 1975). Bald eagle habitat exists along the shoreline of Lake Pend Orielle.

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle is a large raptor with a white head and tail and a dark brown body. Juvenile eagles are completely dark brown and do not fully develop adult plumage until they are five or six years old. Adults average about three feet from head to tail, weigh approximately 10 to 12 pounds and have a wingspread up to seven feet. The primary food source for bald eagles is fish, but they also feed on a variety of birds, mammals, and turtles (both live and as carrion). Female bald eagles are usually larger than the males. Breeding pairs of bald eagles unite for life or until the death of their mate. The breeding season varies and typically begins in the winter for the southern populations and progressively shifts toward spring the further north the populations occur. Eagles pairs may use the same nest year after year. Breeding pairs of bald eagles unite for life or until the death of their mate. Female eagles lay one to three eggs, which are incubated for about 35 days. The young fledge 9 to 14 weeks after hatching and at approximately 4 months the young eaglets are on their own (National Geographic Society 1995, Buehler 2000, U. S. Fish and Wildlife Service Division of Endangered Species 2001).

The bald eagle historically ranged throughout North America except extreme northern Alaska and Canada, and central and southern Mexico. Prior to 1940, the eagle population began to decrease due to the decline in numbers of prey species, direct killing and loss of habitat. In 1940, the Bald Eagle Protection Act was passed, which made it illegal to kill, harm, harass, or possess bald eagles, alive or dead. This act also made it illegal for people to possess eggs, feathers and nests. The bald eagle began to partially recover due to this act. However, the use of dichloro diphenyl trichloroethane (DDT) to control mosquitoes became very widespread along coastal and wetland areas before World War II. The chemical contaminated food eaten by eagles and caused a decline in the population. The principal breakdown product of DDT, dichloro diphenyl dichloroethylene (DDE), built up in the fatty tissues of adult females. This prevented the calcium release necessary to produce strong eggshells, which caused reproductive failure. Bald Eagle numbers in the lower 48 states are thought to have declined from between 25,000 - 75,000 nesting birds to fewer than 450 nesting pairs by the early 1960's. The Secretary of the Interior, on March 11, 1967, listed those populations of the bald eagle south of the 40th parallel as endangered under the Endangered Species Preservation Act of 1966. However, the decline continued until DDT was banned from use in the United States on December 31, 1972. Bald eagles became protected in all areas of the U. S. below the 40th parallel under the Endangered Species Act in 1973, with an exception for Michigan, Minnesota, Wisconsin, Washington and Oregon. The eagle was listed as threatened in these states. On August 11, 1995, the U.S. Fish and Wildlife Service reclassified the bald eagle from endangered to threatened in the lower 48 states. Currently, there are more than 4,000 adult Bald Eagle nesting pairs. Though the bald eagle has recently been reclassified to threatened, this action does not alter those conservation measures already in effect to protect the species and its habitat. Periodic review of the status of the species will continue through annual surveys and bird banding own (National Geographic Society 1995, Buehler 2000, U. S. Fish and Wildlife Service Division of Endangered Species 2001).

Brown-headed Cowbird (*Molothrus ater*)

Parasitism by the brown-headed cowbird is causing the decline of many bird species. This species has the greatest rate of increase and largest expansion in population of any native bird species. Cowbirds travel into forested areas to lay eggs in host nests.

Small birds that have open cup nests (flycatchers, phoebes, vireos, warblers, and sparrows) and long incubation periods are the host species of cowbirds. Female cowbirds can lie up to 30-40 eggs a year and affect the reproductive success of many bird species. Birds that inhabit forest edges and/or second growth forests are heavily parasitized by cowbirds. Species with a restricted geographic breeding range and with fragmented habitat, threatened by direct destruction, and fire suppressed plant communities have experienced the largest decline (Finch et al. 1997). Farragut State Park experienced heavy forest fragmentation with the establishment of the Farragut Naval Training Station. This fragmentation created a high amount of forest edge, which is ideal habitat for the brown-headed cowbird.

Snags

Most cavity nesting birds prefer snags with a diameter > 15 inches and select specific stages of snag decomposition for feeding and nesting. Soft and rotten snags are used mostly by cavity nesting wildlife. However, some woodpeckers prefer hard snags. Cavities can occur naturally, be excavated, or be formed by spaces under loose bark (Thomas et al. 1979). Primary excavators are those species that actually construct nesting and foraging cavities in snags. Secondary cavity users use either natural cavities or cavities constructed by other species. Balda (1975) and Scott (1978) found that snags do not become suitable for nesting until 6 years after the death of a tree. Snags that retain more than 40% of their bark are used more frequently and contain more holes than snags with less bark. Snags in higher diameter (at breast height) classes (≥ 43 cm) are used significantly more than smaller snags and the larger snags contain more holes. Large diameter snags are used more frequently as nest sites and also show more evidence of woodpecker foraging than smaller snags (Bull and Meslow 1977, Mannan et al. 1980, Manuwal and Zarnowitz 1981, and Rapael 1980). Greater numbers of cavity nesting wildlife are present when large snags are available (Balda 1975, Haapanan 1965, Mannan et al. 1980, Raphael and White 1984, Scott 1979). Snags on northern and southern aspects are used at the same frequency, but northern exposure snags average more holes per snag. Natural cavities and cavities constructed by primary excavators in snags provide thermally regulated enclosures for nesting and wintering animals. The thick walls of natural cavities moderate temperature fluctuations, which may result in increased animal survival and higher production then for open nests (Beebe 1974, Conner 1979, McComb and Noble 1981). They are also protected from stormy weather and during the winter. Roosting in cavities may reduce winter mortality and allow a species to occur farther north (Von Haartman 1968). Snags may be important in courtship and the reproduction phase of birds. Drumming by woodpeckers may be a part of their social behavior. It is theorized that it is part of courtship and territorial defense.

Raphael and White (1984) found that use of snags as foraging substrate varied among wildlife species. Hairy woodpeckers and black-backed woodpeckers fed in snags 70-79% of the time, while red-breasted nuthatches didn't forage on snags. A number of avian and mammal species use snags as food storage sites. The American kestrel, some owls, and a variety of mammals use dead trees to cache prey and other food items. Snags provide three foraging substrates for birds and mammals: external surface of the bark, the cambium layer, and the heartwood of the tree (Evans and Conner 1979, Gale 1973, Mannan et al. 1980, and Raphael 1980). The moisture and texture content of wood fibers change as a snag decomposes. These changes affect suitability of the snag as insect habitat. Birds may play a significant role in regulation of insect populations. Most of the snag-dependent birds and mammals in northern Idaho are insectivorous (Thomas et al. 1979). Holmes (1990) found that birds do not prevent epidemic outbreaks of their insect prey, but do have an impact on endemic prey levels. So, birds can delay insect outbreaks.

Populations of snag-dependent wildlife are maintained by retaining the appropriate number, species, and size of snags in the proper stages of deterioration through space and time. Snag deterioration is caused by the interaction of insects, fungi, bacteria, and weather over time (Kimmey and Furniss 1943). Dead trees deteriorate from top to bottom and result in a decrease in snag height and the loss of needles, bark, and wood. Snag deterioration from sapwood to heartwood causes hard snags to become soft. There are five stages of snag deterioration. In stage 1 of snag deterioration, wood boring beetles become active and woodpeckers take advantage of this source of food (Cline et al. 1980, Mannan et al. 1980). Large limbs that persist in the first and second stages of deterioration provide perches for raptors and other birds. Stages 2-5 provide many species of wildlife with potential breeding sites. Red-breasted nuthatch frequently nests near the top of snags in the second stage of deterioration, while northern flickers prefer snags in more advanced stages of decay (Mannan et al. 1980). Brown creepers and some bats roost or nest behind loose bark in the third and fourth stages of snag deterioration. The northern flicker typically nests in open situations, while the red-breasted nuthatch utilizes densely forested areas. Other structural features, such as large snags or down logs containing carpenter ants, provide a winter forage substrate for pileated woodpeckers (McClelland 1977).

Effects of Recreation on Birds

Plant composition changes in recreation sites. Vegetation, dead wood and brush piles are reduced. Recreators modify habitat by trampling vegetation and harvesting fire wood. Trampling compacts soil, decreases soil porosity, and increases soil erosion. The impact to soil along with vegetation reduces seed germination, seedling establishment, plant growth, and reproduction. Disturbance favors plant species that are very small or very large, low growing, with tough leaves, and annuals that grow rapidly and have copious seed production. Plant species diversity is reduced with extreme recreation disturbance, but may increase with low to moderate recreation levels.

Camping is one of the most destructive recreation activities. Most responses of songbirds to camping are indirect reactions to human intrusion. Vegetation in newly established campsites usually changes within a year as it is trampled and soil becomes compacted. Plant coverage declines and erosion increases. Dead and downed wood is scavenged for fires or removed for safety.

Habitat changes cause the greatest reduction in bird species that rely on shrub and ground cover and standing dead and down woody debris. Dark-eyed juncos, vireos, wrens, and deep forest species will decline with the removal of ground, shrub, and mid-canopy cover. Cavity nesters, bark drillers, and other birds will also decline with the loss of forage on down woody debris and snags. Brewer's blackbirds, mountain chickadees, Stellar jays, American crows, and common ravens are common around campgrounds and benefit for the change in habitat. Open-nesting birds will decline in productivity as food increases for nest predators and parasites (brown-headed cowbird). Warblers, vireos, and flycatchers are most susceptible to cowbird parasitism. Roads have minor and indirect effects on songbirds after road building eliminates habitat. Roads may decrease songbird productivity because increased road kills and litter may subsidize nest predators and provide them with foraging corridors into the forest interior. In addition, trails may be used by predators and parasites (brown-headed cowbird) to gain access to forest interiors. Recreators may increase the spread of exotic plants by acting as dispersal agents.

Birds may habituate to predictable disturbances such as walking, driving or camping. Effects may be pronounced during the early part of the nesting cycle when nest construction and incubation occur. Disturbance during the winter may be important to permanent residents, especially when cold temperatures and deep snow increase energetic requirements and decrease foraging efficiency. Animals that feed in social groups may respond quicker to disturbance then solitary birds because of increased vigilance and the past experiences of other individuals. Therefore, social species (pygmy nuthatch, red crossbill, evening grosbeak, and pine siskin) may be less tolerant. Predators may be more tolerant of human activity than nesting birds and may cue in on human activity to locate nests. Repeated intrusions in songbird territories during the breeding season can decrease singing, increase or decrease nest defense, and increase predation. These changes may reduce the productivity of individuals and influence community composition.

E. SMALL ANIMALS (MAMMALS, REPTILES AND AMPHIBIANS), DOWN WOODY DEBRIS AND LOGS

Down woody debris and logs are important habitat requirements for many mammals, reptiles, and amphibians. Woody materials furnish cover and serve as sites for feeding, reproducing, and nesting (Maser et al. 1979). As a log loses density, it becomes easier for small mammals to burrow inside. The larger the diameter and the greater the length of a log the more useful it is to wildlife (Maser et al. 1979). Various animals use logs as feeding sites. Food is carried to a log where it is eaten or stored or it can be obtained from the log itself. Some reptiles, birds, and mammals reproduce alongside, under, or within logs (Maser et al. 1979).

Class 1 logs with support points offer hiding and thermal cover for snowshoe hares, porcupines, and other animals that can get underneath them. The sides and top of class 1 logs are primary feeding sites for western fence lizards. Mammals, such as red squirrels and northern flying squirrels, feed on the top of these logs. Raptors, such as the goshawk, use them as sites on which to pluck feathers or fur from their prey. Class 1 logs are high enough off the ground that the ruffed grouse nest under them. Snowshoe hares may also rear young under these logs (Maser et al. 1979).

Class 2 logs are weakened and sag slightly on the support points. The bark is beginning to loosen. As it settles closer to the ground, duff and soil build up around it and it becomes cover for small animals (gopher snakes, dusky shrews, yellow pine chipmunks, and long-tailed voles. Class 2 logs function as feeding sites like class 1 logs. However, as the log settles, small animals (winter wrens and deer mice) eat food from under it. After the log sinks into the ground, smaller animals (winter wrens) nest under it. Mice will also nest under the loose bark (Maser et al. 1979).

Class 3 logs have loose bark and the support points are gone. The log sags and interfaces with the ground. The space between the bark and the wood provides hiding and thermal cover. Moist microclimates provide habitat for species like the Pacific tree frog. Deer mice and red-backed voles form runways alongside the log and under it. Loose bark allows small animals (Pacific tree frog and western skink) to catch invertebrates between the loose bark and the wood. Decomposition of a late class 3 log also allows shrews to hunt invertebrate prey alongside and under the log. Class 3 logs with tall grasses growing alongside them are used by juncos for nesting. In addition, shrews, mice, and voles nest in burrows under these logs, while porcupines give birth alongside them (Maser et a. 1979).

Class 4 logs are completely on the ground and may be partly buried. The interior is soft enough for small animals to burrow inside the log. Dusky shrews, deer mice, red-backed voles, weasels and other small mammals establish burrow systems beneath the log and use the interior. These burrow systems are used by amphibians (western toads, salamanders, and frogs) and reptiles (western skinks, gopher snakes, and lizards). Rubber boas, ringneck snakes, dusky shrews, deer mice, and red-backed voles feed around, under, and inside these logs. Deer mice, red squirrels, gopher snakes, and other reptiles use the interior of the logs for reproduction sites (Maser et al. 1979).

Class 5 logs are soft, powdery, and mostly buried by soil and litter. These logs have well established burrow systems both within and beneath them. These burrows are mainly used by mammals and sometimes by amphibians and reptiles. Tree squirrels stash their cones inside the logs from late class 4 through class 5. Shrews feed within class 5 logs, and red-backed voles begin to glean fungi from the interior. There is also an increase in feeding activity of small animals alongside and under class 5 logs, which corresponds with an increase in the invertebrate fauna (Maser et al. 1979).

Classes 1-3 are the only logs that serve as sites for cavity nesters (Maser et al. 1979). These logs also serve as lookout posts for animals like the yellow pine chipmunks and Columbian ground squirrels. Ruffed grouse also use them as drumming sites, and lizards use them for sunning. Deer and elk bed on the upslope side of logs. Class 4 and 5 logs are dusting sites for grouse and other birds. Deer and elk use class 5 logs for bedding. Hollow logs of any class are important for cover and dens for snowshoe hares, bushy-tailed woodrats, weasels, skunks, raccoons, and black bears (Maser et al. 1979).

VII. MANAGEMENT AND OWNERSHIP, STRUCTURES, UTILITIES, AND TRANSPORTATION

A. MANAGEMENT AND OWNERSHIP

The Idaho Department of Parks and Recreation and the Idaho Department of Fish and Game have a cooperative management agreement. The Idaho Department of Fish and Game (IDFG) is assigned a conditional deed on the north management zone of Farragut State Park. According to the deed, the land can only be used for wildlife purposes. Development and uses other than wildlife are prohibited. Violation of the deed would result in the land reverting back to the GSA. However, hiking, bicycling, equestrian use, interpretive wildlife and plant programs and wildlife viewing stations may be established in this zone. IDFG has title on four shoreline parcels near Idlewilde Bay, which are also under this agreement.

The majority of land around Farragut State Park is privately owned. Private land is adjacent to the entire northern park boundary and most of the east and west park boundary. The remaining ownership around the park is state or federal. State lands are along the south park boundary. Federal lands are found at the U. S. Navy Research and Development facility in Bayview, ID and the Idaho Panhandle National Forests. The Idaho Panhandle National Forests land is near the southeast corner of the park

B. STRUCTURES, UTILITIES, AND TRANSPORTATION

During the time of the naval training station, Farragut had 776 structures. The station had baseball diamonds, football fields, seven motion picture theatres, supply depots, a 2,500-person auditorium, field houses, and a hospital that could hold 2,700. These structures were removed after the station decommissioning, with the exception of the two water towers, 7 small munitions bunkers, some concrete foundations and floor slabs, and the Brig (Figure 11). Currently, Farragut State Park includes 50 buildings including the above 10 (Figure 12). Five staff residences and the maintenance shop are near the visitor center

Visitor Day Facilities

The Visitor Center is near the east entrance. It includes space for staff offices, visitor and registration/reservation information, a display room and a small gift store. A restroom/shower building is provided for visitors at Beaver Bay Swim Area, along with the man made swimming area. Locust Grove is a picnic area with space for 100 people, restroom, shelter, and is the location for the beginning of the 18 hole, tournament class, Wild and Wooly Wreckreator Disc Golf Course. At the 4 lane Boat Launch is a restroom, parking for about 100 vehicles, docks, and a boat sewage pump-out. Flyer’s Field has 2 vault toilets, a grass landing field and other accoutrements to meet model airplane flying safety standards. The Shooting Range has vault toilets and a rain shelter. Site plans are in process for future development. Sunrise and Willow day use areas have 2 picnic shelters, vault toilets and beautiful views over the lake (Figure 12 and 13).

Visitor Group Camping Facilities

There are 3 camps at Buttonhook: Larch, Ocean Spray, and Saw-whet. These camps are designed for group tent camping for about 200 people. Vault toilets are at the camps, while a flush toilet is nearby for boaters who use the docks on Buttonhook Bay. The swimming area is a 5-minute walk away, with showers. Thimbleberry Camp is the location for day use parking for horseback riders. The camp has a flush restroom. Horseback riders also have six campsites nearby. Additional campsites are at Kestrel and Nighthawk. Kestrel has 25 sites, while Nighthawk has 50 sites. Showers and restrooms are available. Larger groups reserve either or both sites and have use of a shelter. These sites also are used for family camping (Figure 12 and 13).

Visitor Single Family Camping Facilities

Whitetail and Snowberry Camps provide sites for single families. Whitetail has 63 sites with a flush restroom and showers. Snowberry has 45 sites with a flush restroom, showers, water and electric hookups (Figure 12 and 13).

Power, Roads and Trails

The U. S. Navy constructed the first electrical power system with the establishment of the Farragut Naval Training Station. The system was abandoned after the decommissioning of the station. The abandoned system was remodeled for Boy Scout Jamborees. It has further been remodeled to accommodate the present needs of the park. Currently, Farragut State Park has 14.7 miles of power line (Figure 14). It services park headquarters, the shop, residences, Snowberry campground, the well houses, the water towers, and the Sunrise Day Use area. Farragut has 36.2 miles of roads (Figure 15). About 33.4 miles of shared use trails are in the park (Figure 16). Many people use the roadsides as trails. The transportation network is composed of several road and trail types (Table 4). State Highway 54 is the access travel route to Farragut State Park.

Table 4. Transportation network within Farragut State Park.

Type	Miles
Highway 54	6.2
Primary Paved Road	12.0
Secondary Paved Road	14.7
One Lane Gravel Road	3.3
Shared Use Trail	33.4

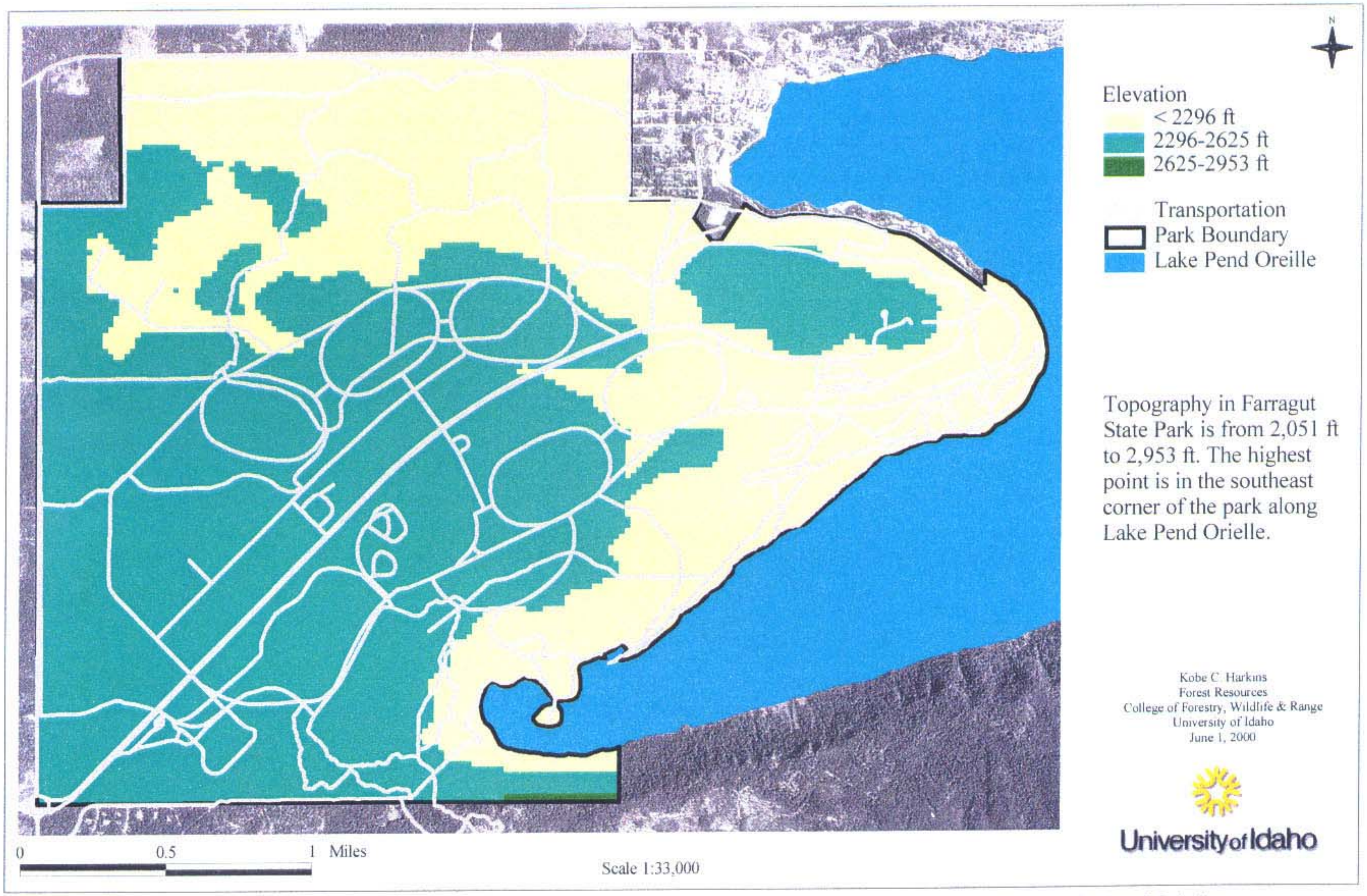

Figure 2. The majority of Farragut State Park consists of gentle terrain. The greatest changes in elevation occur along Lake Pend Orielle.

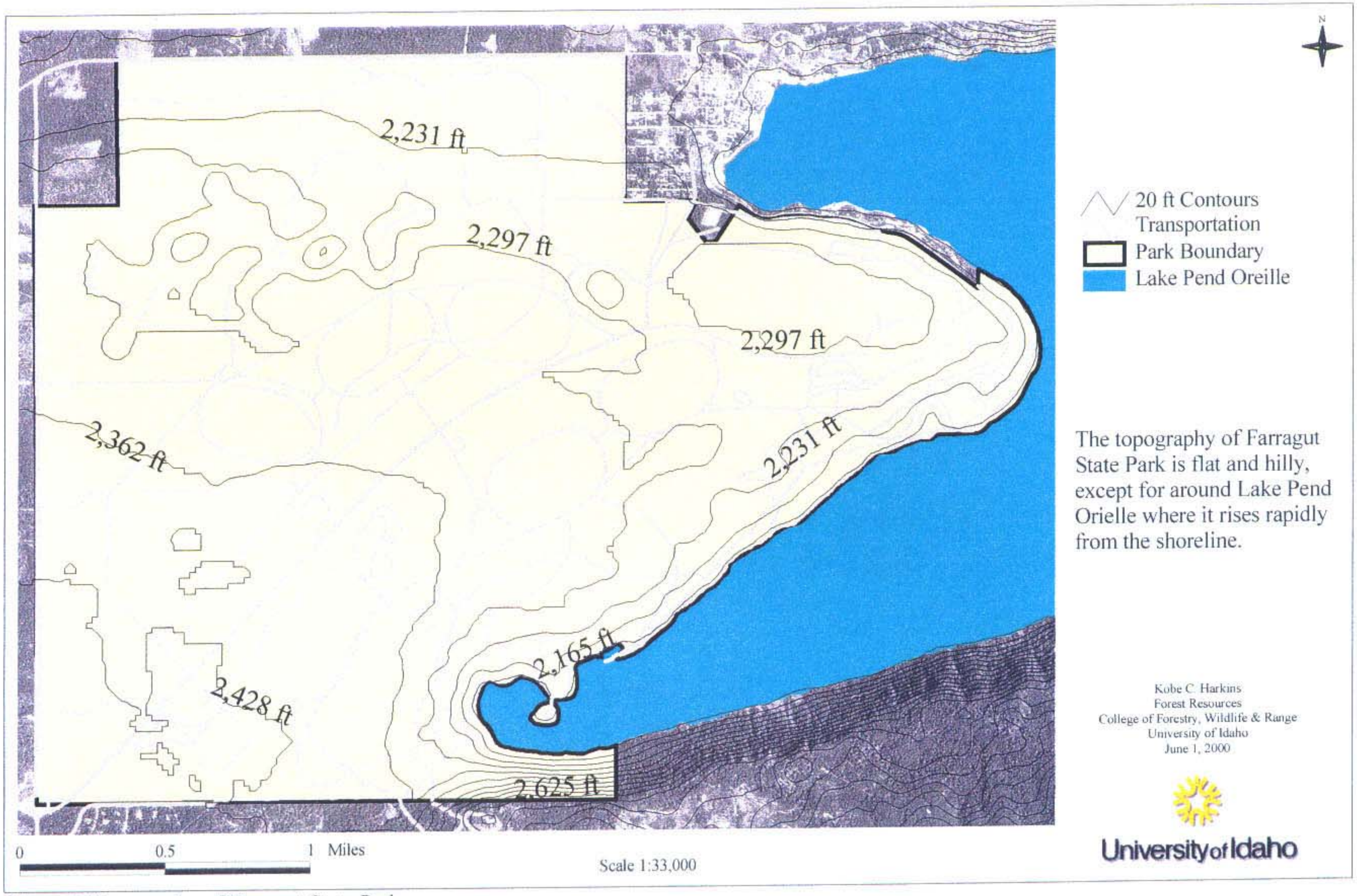

Figure 3. Topography of Farragut State Park.

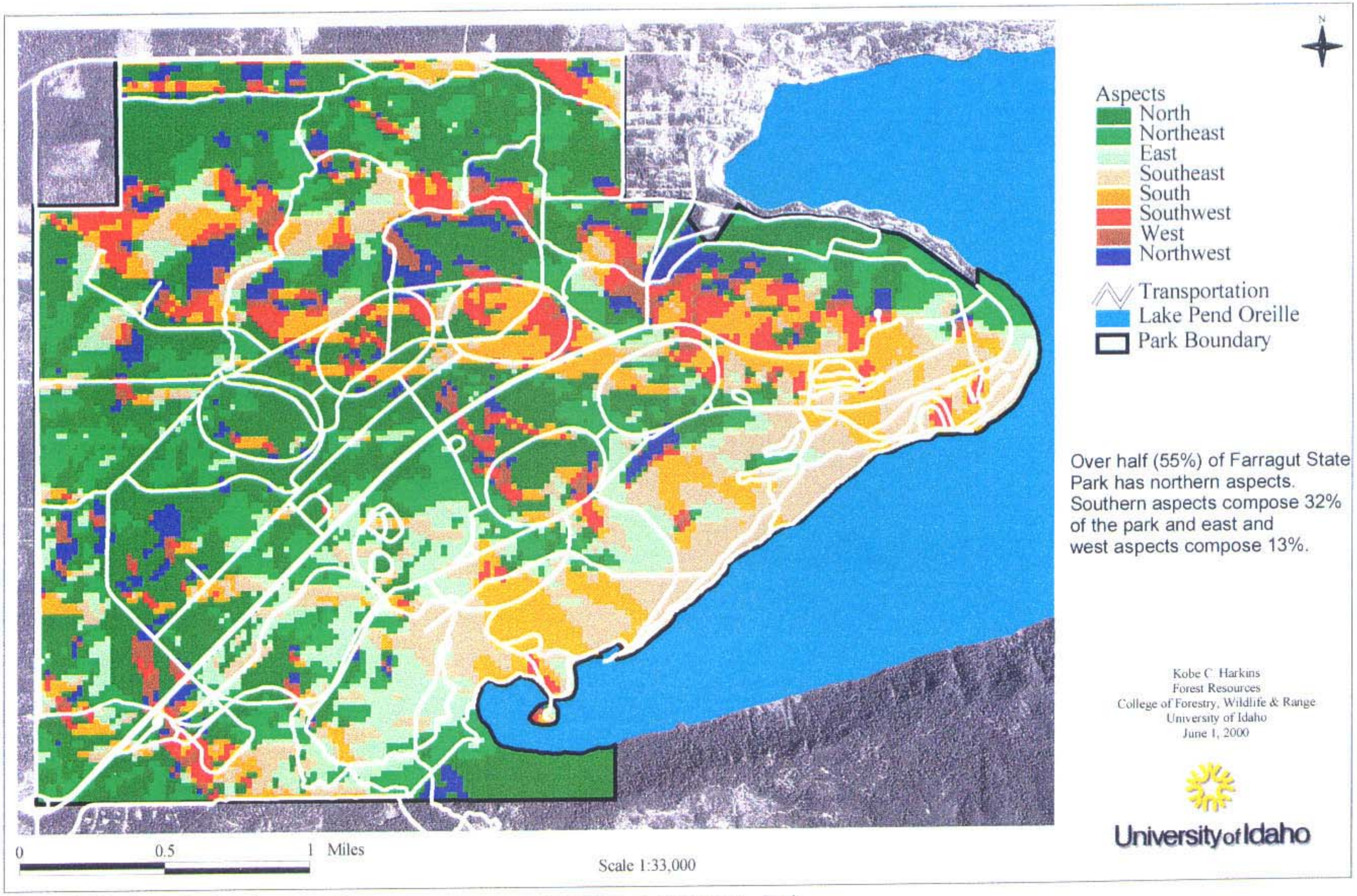

Figure 4. Northerly facing slopes are the most common aspects within Farragut State Park.

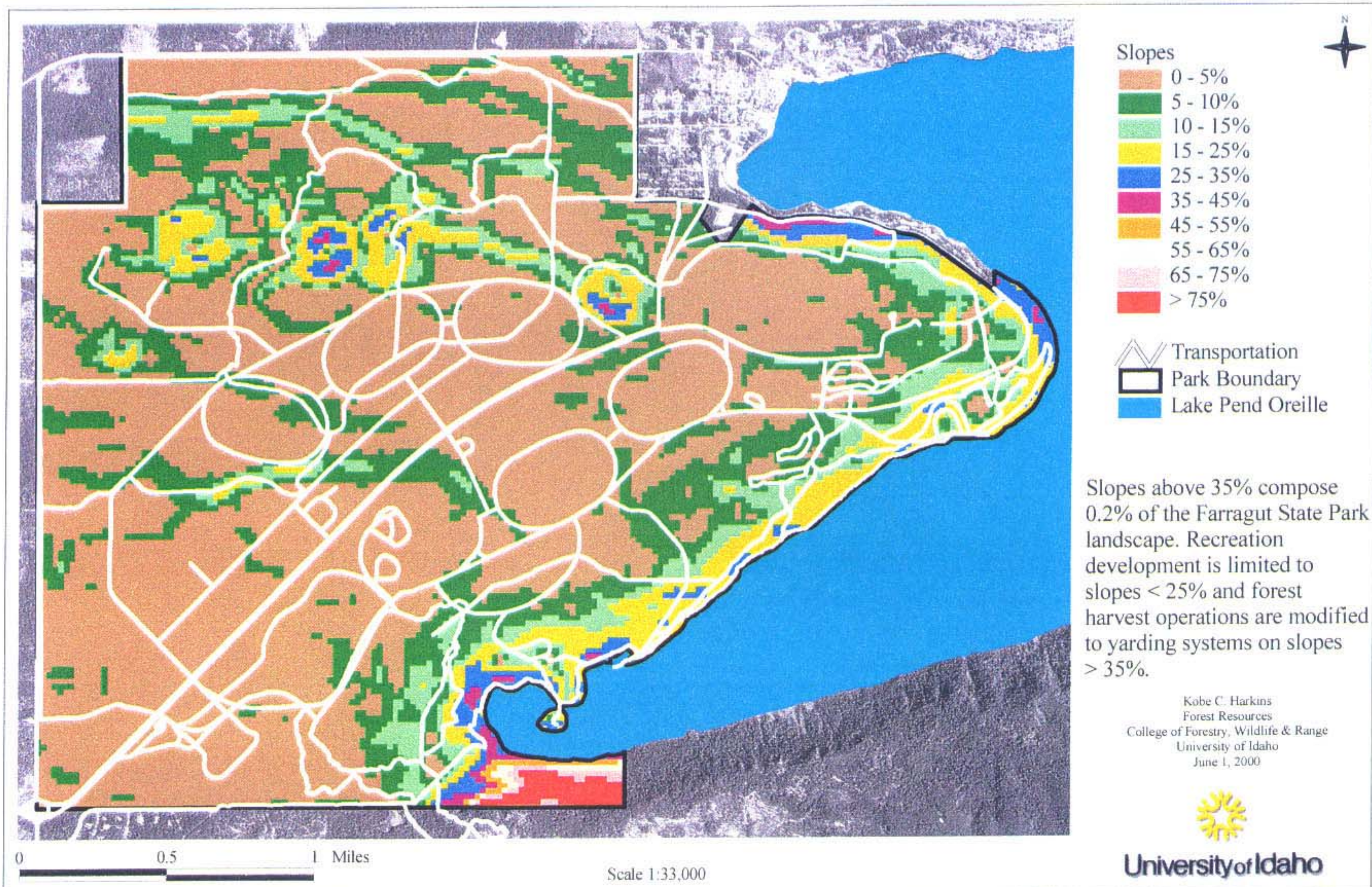

Figure 5. Slopes above 35% are almost non-existent in Farragut State Park.

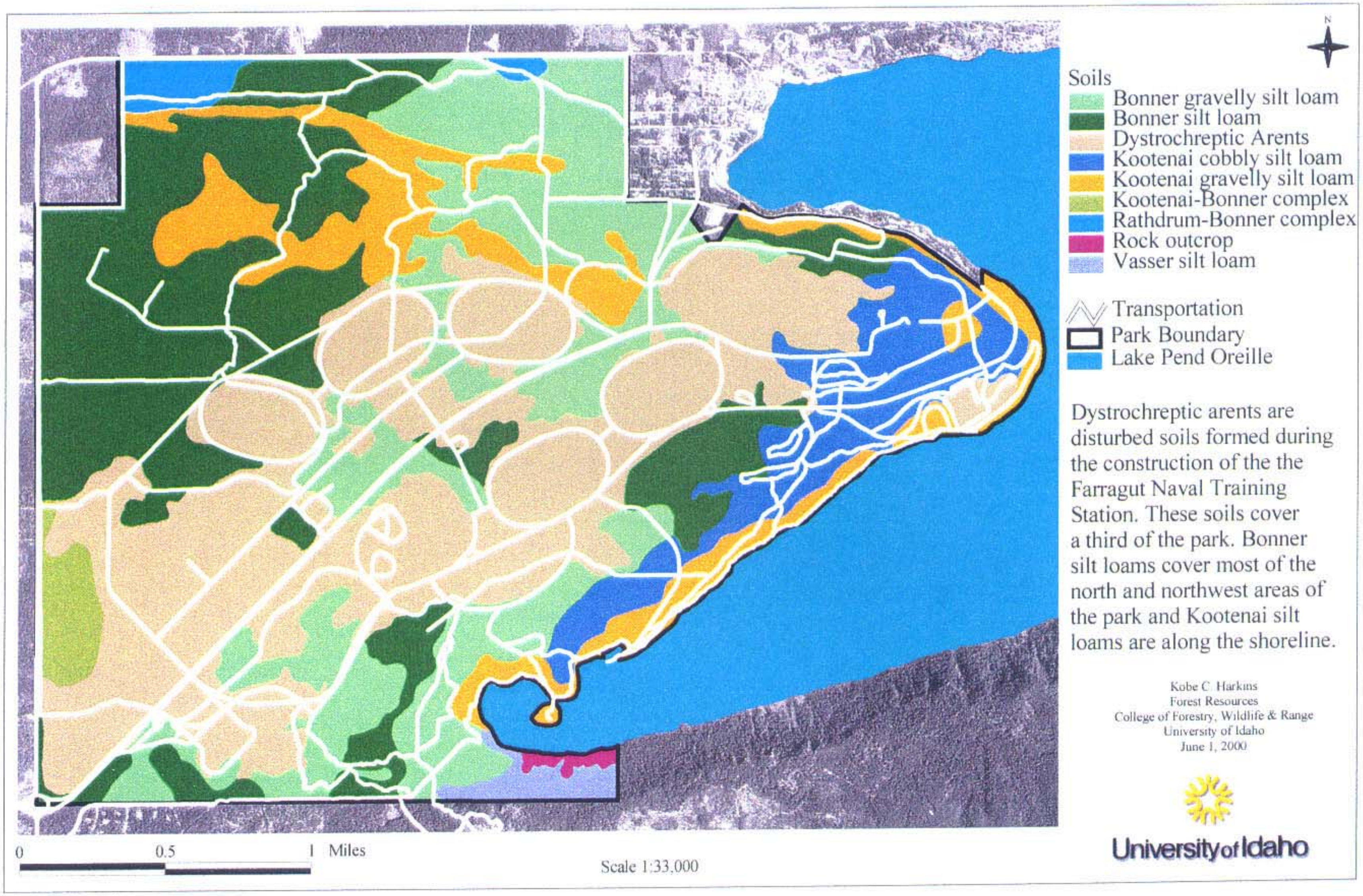

Figure 6. Farragut State Park has nine soil types.

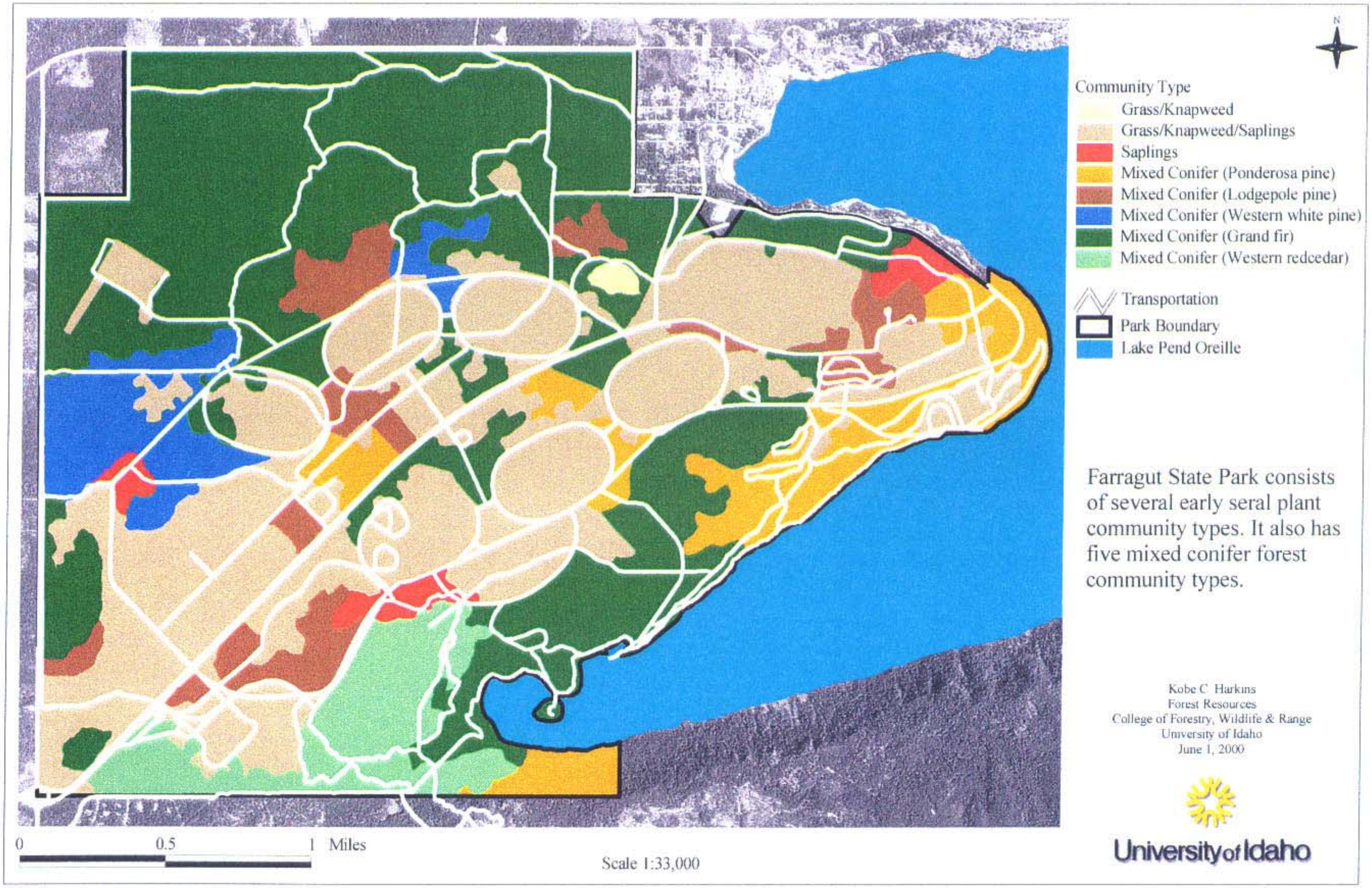

Figure 7. Farragut State Park has eight plant community types.

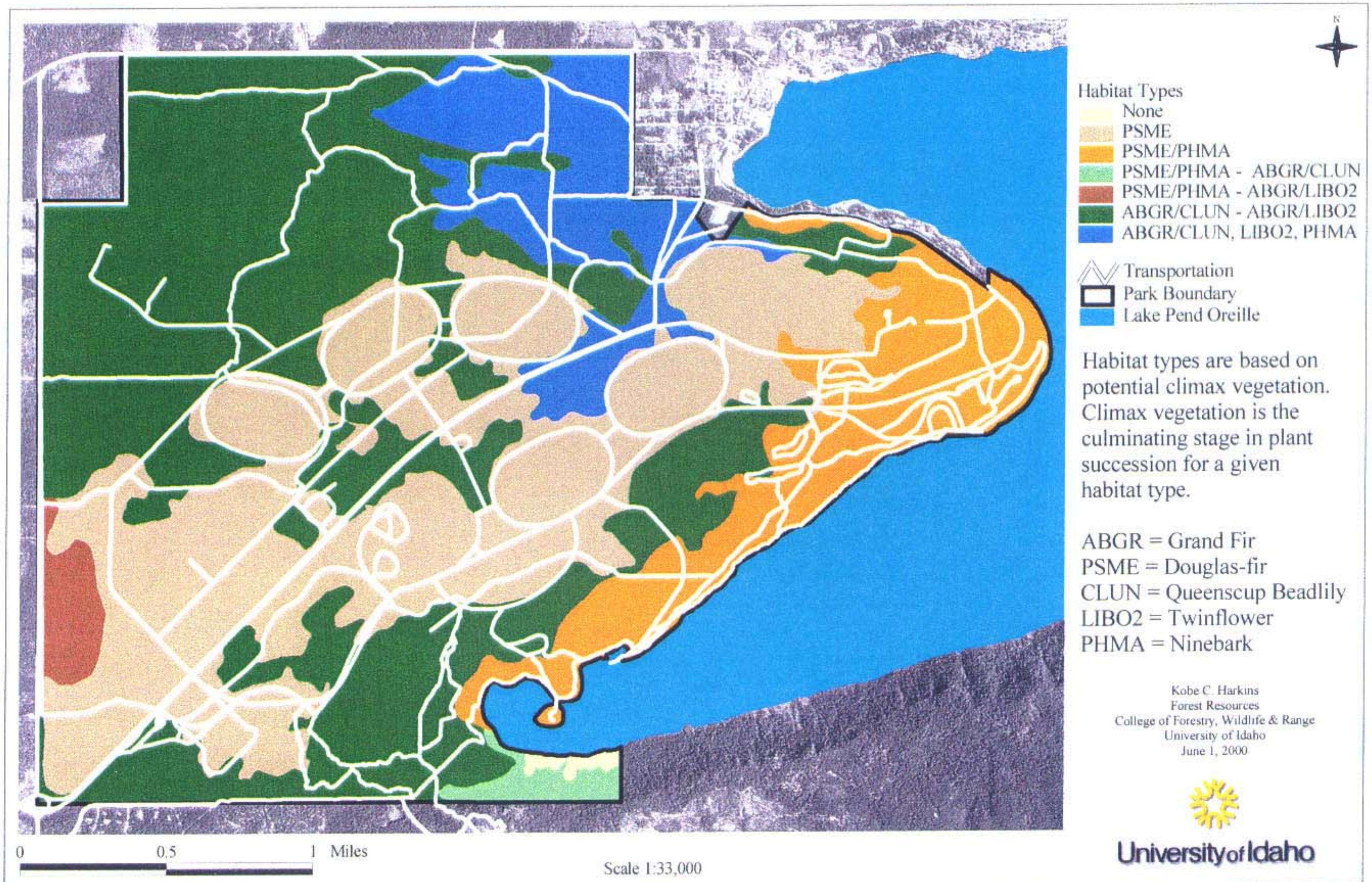

Figure 8. Farragut State Park has six habitat types.

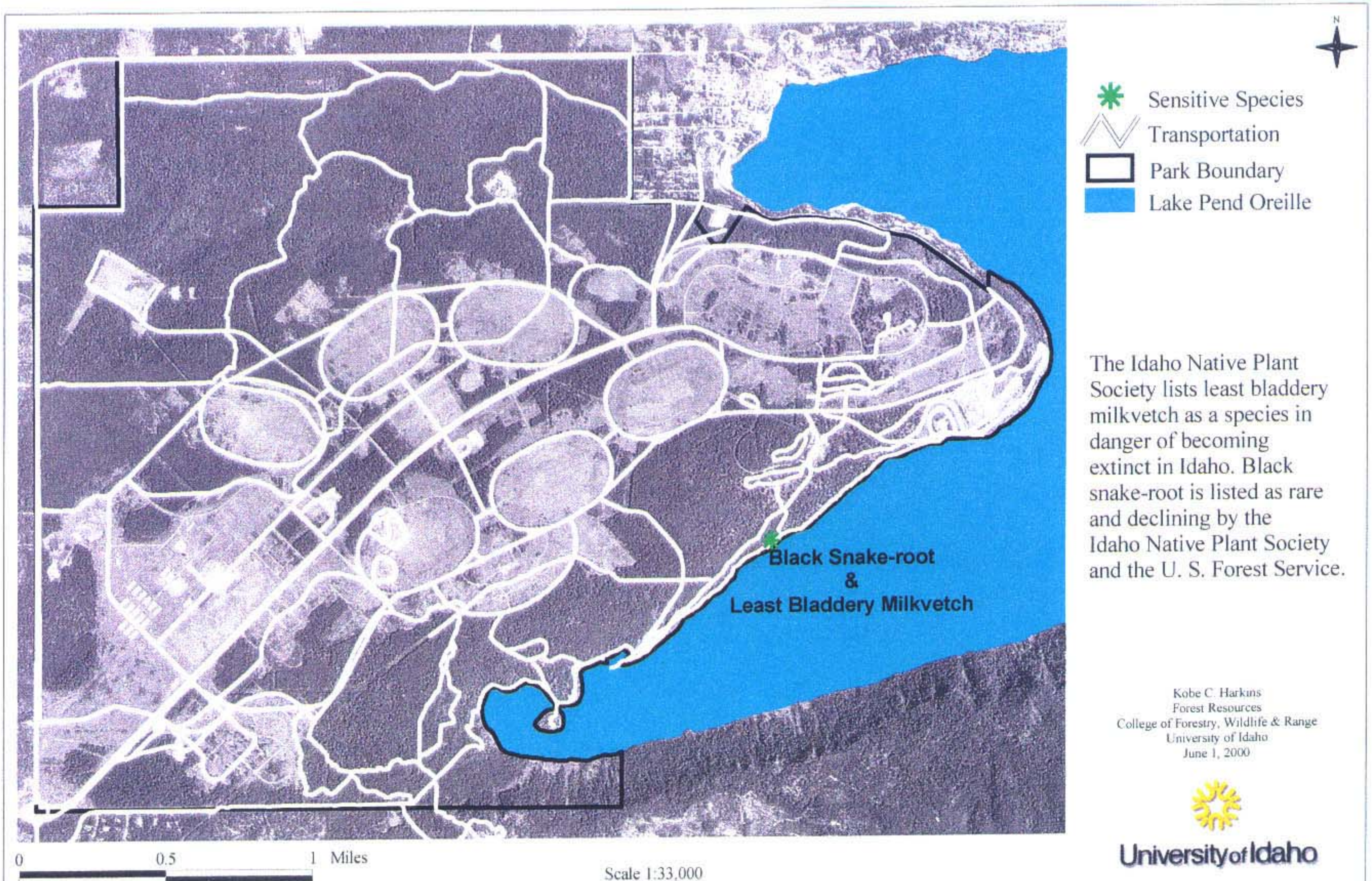

Figure 9. Farragut State Park has two sensitive plant species: black snake-root and least bladdery milkvetch.

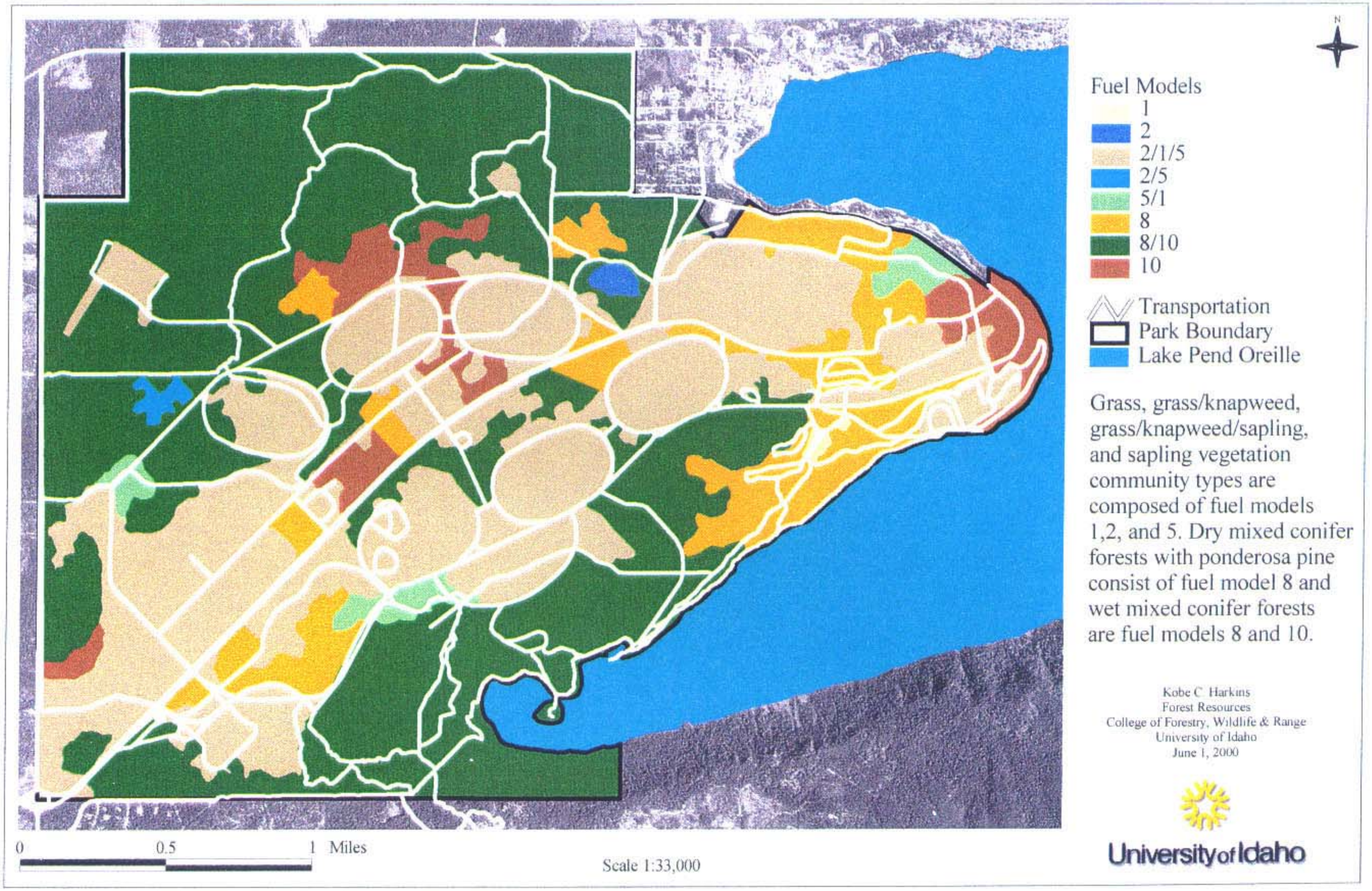

Figure 10. Farragut State Park has eight vegetation fuel model combinations.

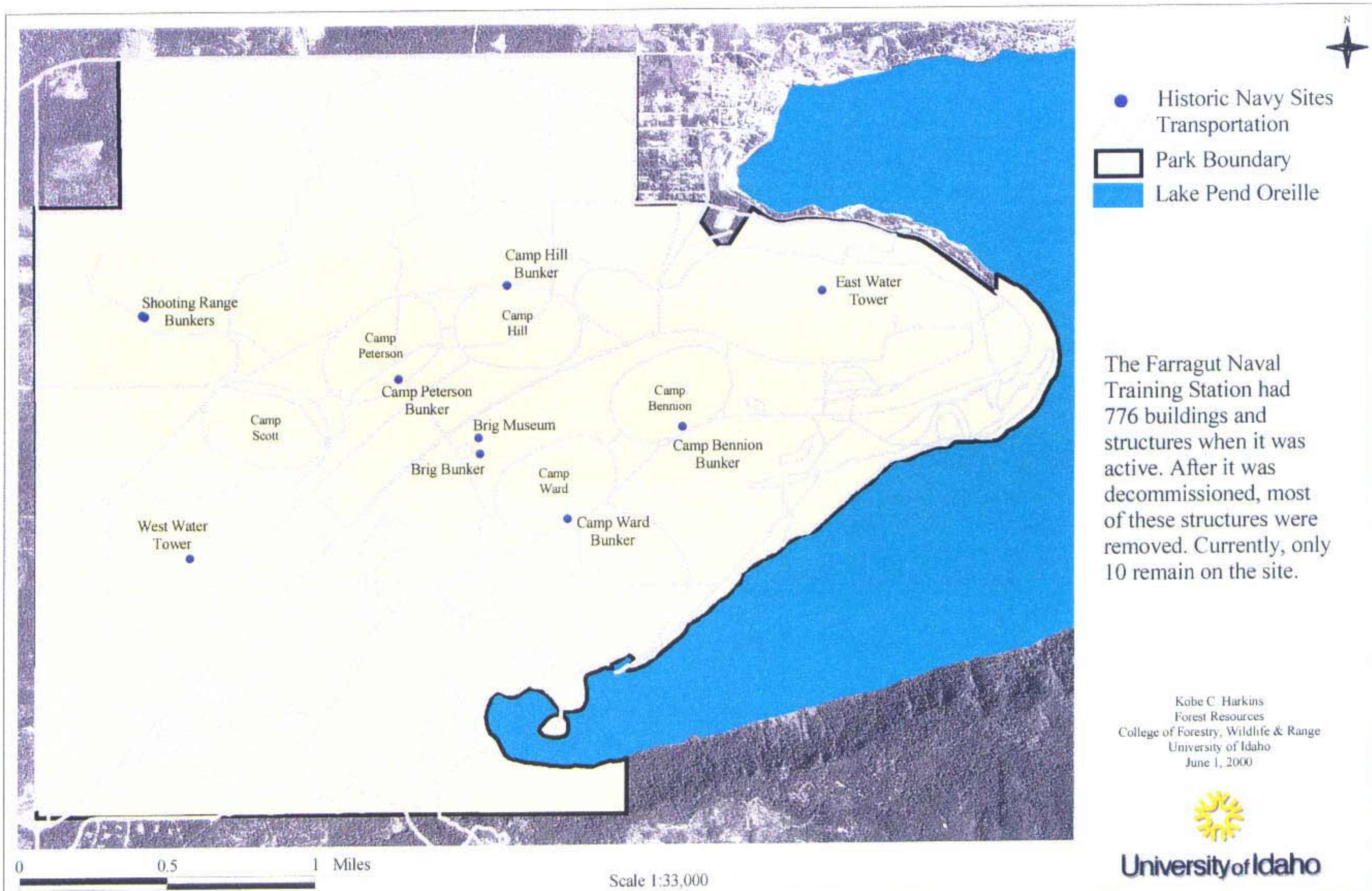

Figure 11. Currently, Farragut State Park has ten historic navy structures and buildings.

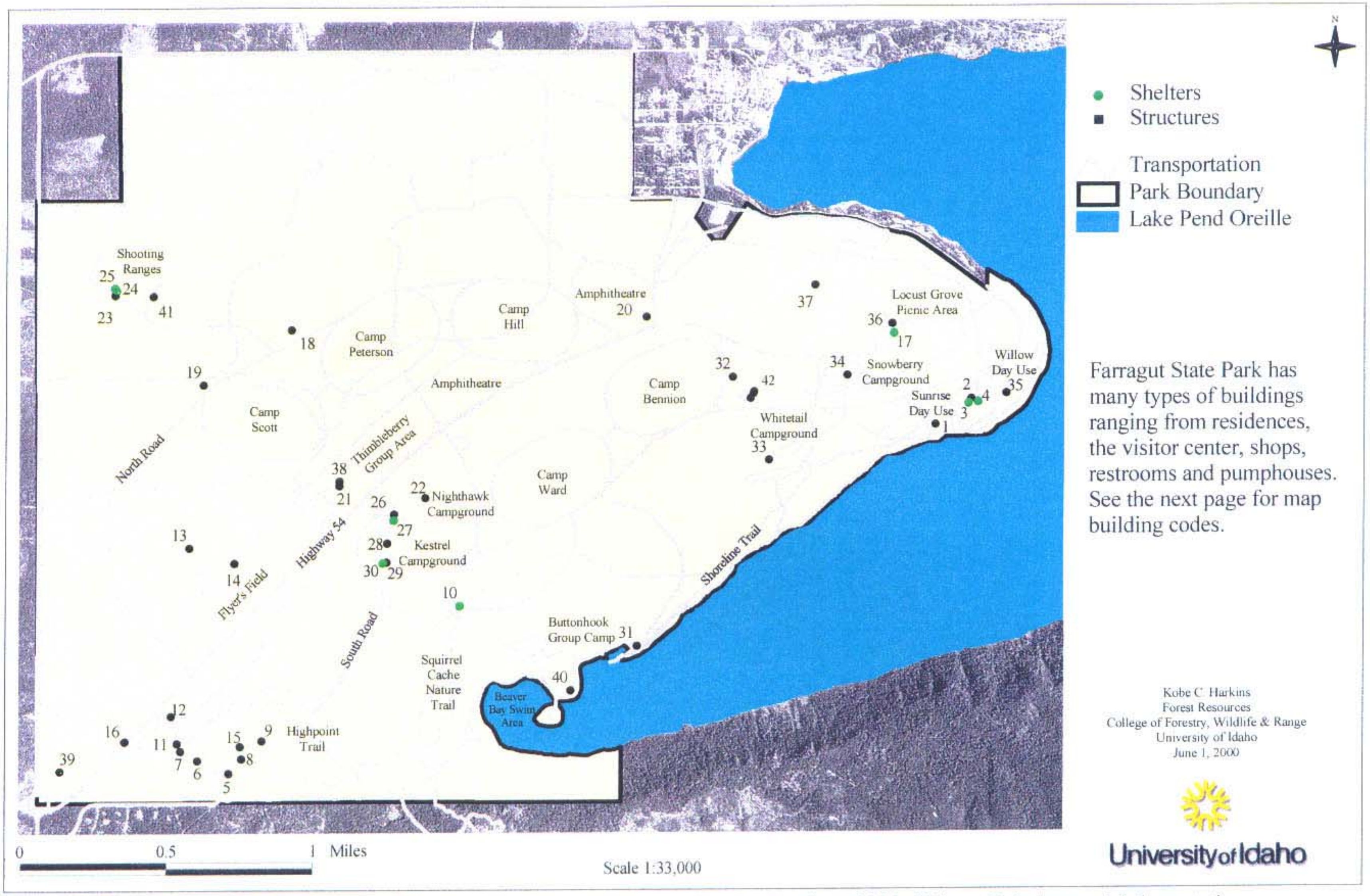

Figure 12. Farragut State Park has 50 buildings and structures. The map provides the location of 33 buildings, 8 shelters and 1 dumpstation.

Table 5. Structures in Farragut State Park

ID Number	Location	Structure
1	Eagle Boat Launch	Restroom
2	Sunrise Day-use Area	Restrooms
3	Sunrise Day-use Area	Shelter (Small)
4	Sunrise Day-use Area	Shelter (Large)
5	Residence/Maintenance Area	Staff Residence
6	Residence/Maintenance Area	Seasonal Quarters
7	Residence/Maintenance Area	Truck Shed (Open)
8	Residence/Maintenance Area	Rangers Residence
9	Residence/Maintenance Area	Manager's Residence
10	Squirrel Cache Nature Trail	Shelter
11	Residence/Maintenance Area	Shop/Ranger Offices
12	Residence/Maintenance Area	Visitors Center
13	West End of Park	Water Tower (West)
14	Fliers Field	Vault Toilets (2)
15	Residence/Maintenance Area	Assist. Manager's Residence
16	Highway 54	Fee Station
17	Locust Grove Picnic Area	Shelter and Group Fire Pit
18	Northwest of Camp Peterson	Pump House No. 3
19	Northwest of Camp Scott	Pump House No. 6
20	Highway 54	Pump House No. 7
21	Thimbleberry Group Camp	Restrooms
22	Northwest of Nighthawk Campground	Shed (Open)
23	Shooting Range	Restrooms
24	Shooting Range	Shooting Shelter
25	Shooting Range	Shooting Shelter 2
26	Nighthawk Campground	Vault Toilets
27	Nighthawk Campground	Shelter with Electric Outlets
28	Kestrel Campground	Vault Toilets
29	Kestrel Campground	Vault Toilets
30	Kestrel Campground	Shelter with Electric Outlets
31	Beaver Bay Swimming Area	Restrooms
32	East of Camp Bennion	Pump House No. 8
33	Whitetail Campground	Restroom/Showers
34	Snowberry Campground	Restrooms/Showers
35	Willow Day-use Area	Restrooms
36	Locust Grove Picnic Area	Restrooms
37	Navy Hospital Area	Water Tower (East)
38	Thimbleberry Group Camp	Fireplace
39	Northeast of West Entrance	Pump House No. 5
40	Buttonhook Group Camp	Restrooms
41	Shooting Range	Storage Building
42	Southwest of Camp Bennion	Dump Station

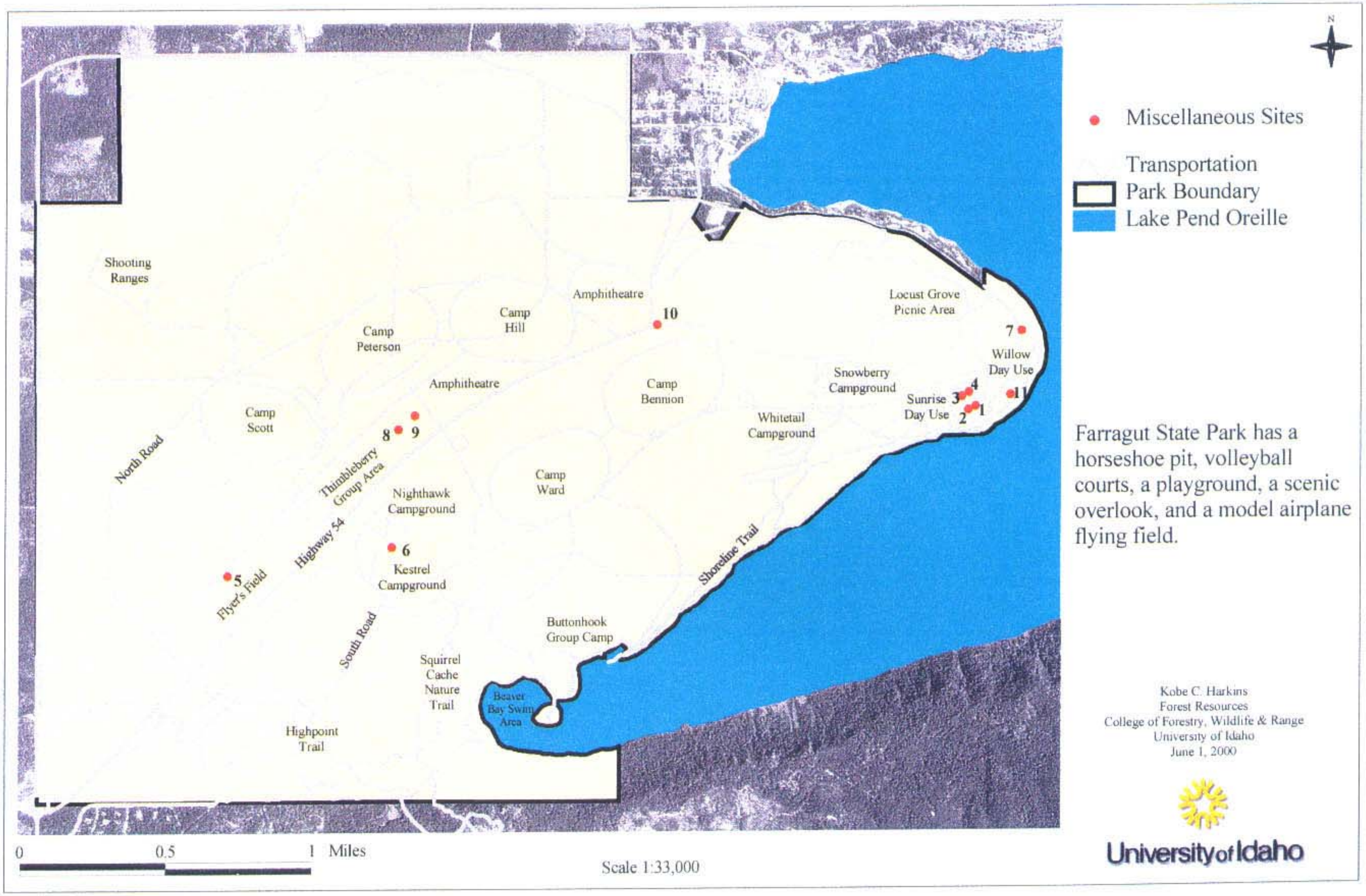

Figure 13. Farragut State Park has 13 activity areas.

Table 6. Activity Areas in Farragut State Park

ID Number	Location	Feature
1	Sunrise Day-use Area	Horse Shoe Pit
2	Sunrise Day-use Area	Volleyball Court
3	Sunrise Day-use Area	Tot Lot
4	Sunrise Day-use Area	Volleyball Court
5	Fliers Field	Model Airplane Flying Field
6	Kestrel Campground	Volleyball Court
7	Jokulhlaup Point	Overlook
8	South of Camp Peterson	Boy Scout Friendship Pole
9	South of Camp Peterson	Boy Scout Friendship Pole
10	Highway 54	East Fee Station
11	Willow Day-use Area	Coin-op Binoculars

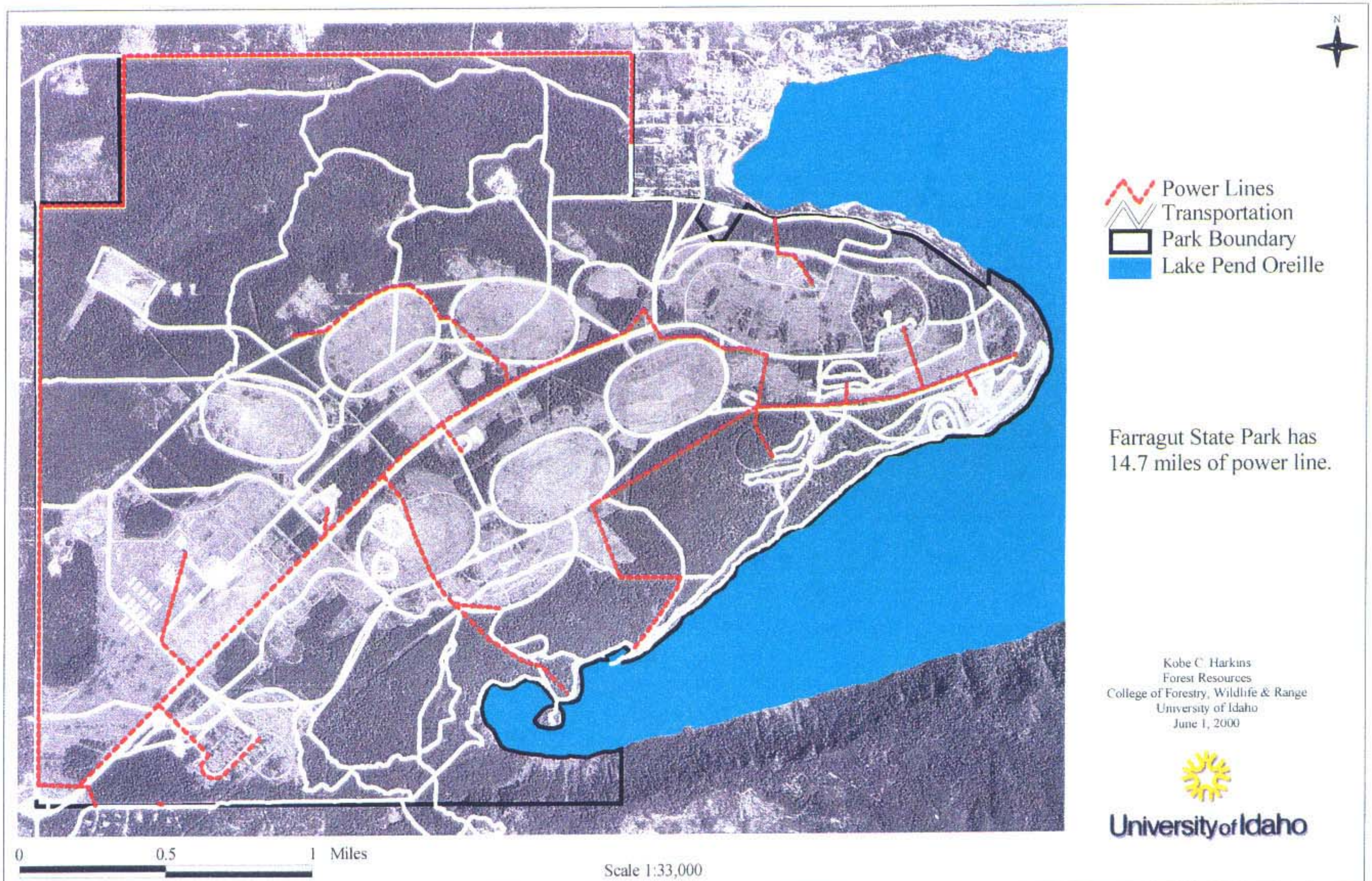

Figure 14. The Farragut Naval Training Station power system was remodeled for Boy Scout Jamborees and park use.

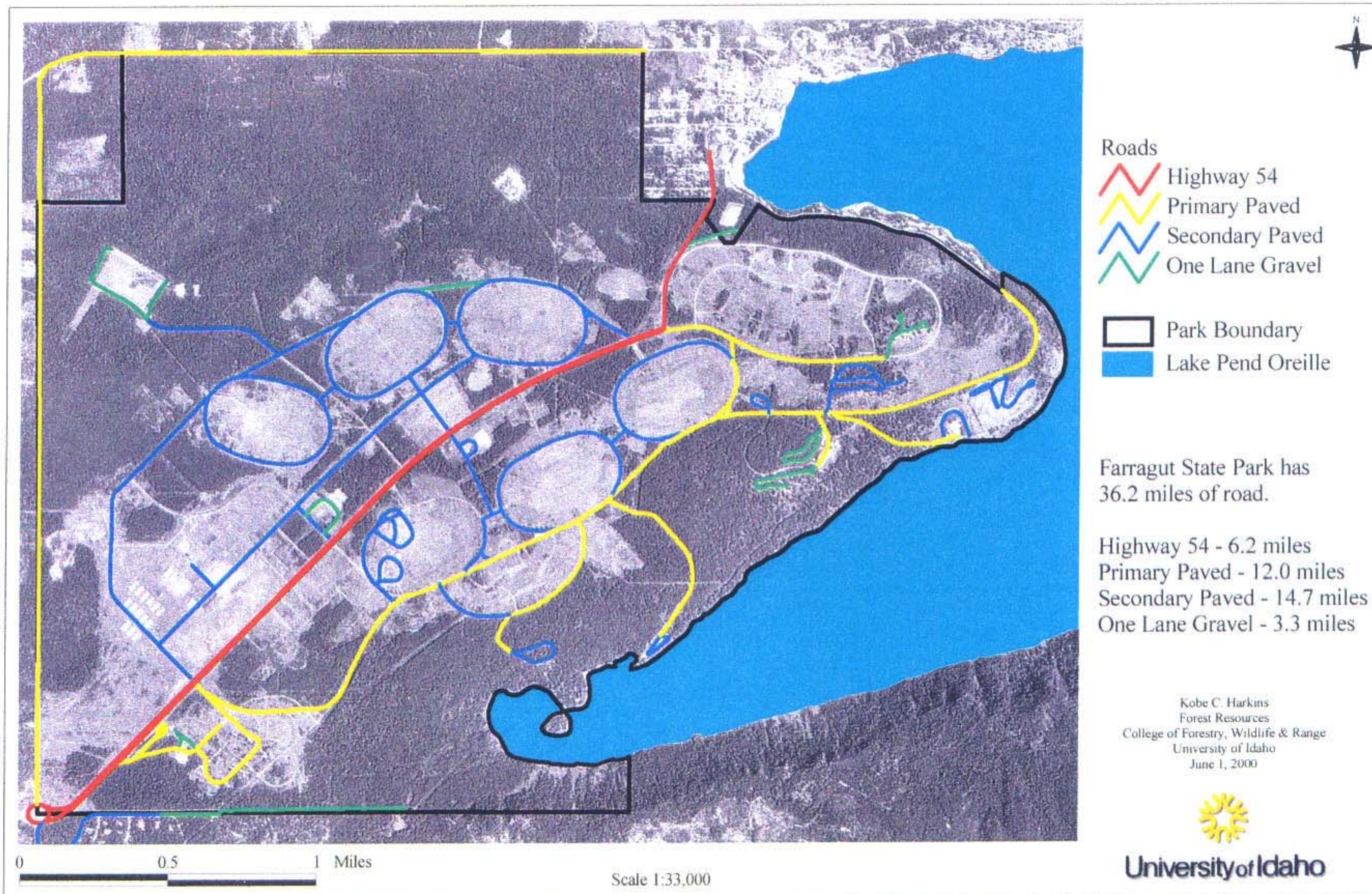

Figure 15. An extensive road system was left behind by the Farragut Naval Training Station.

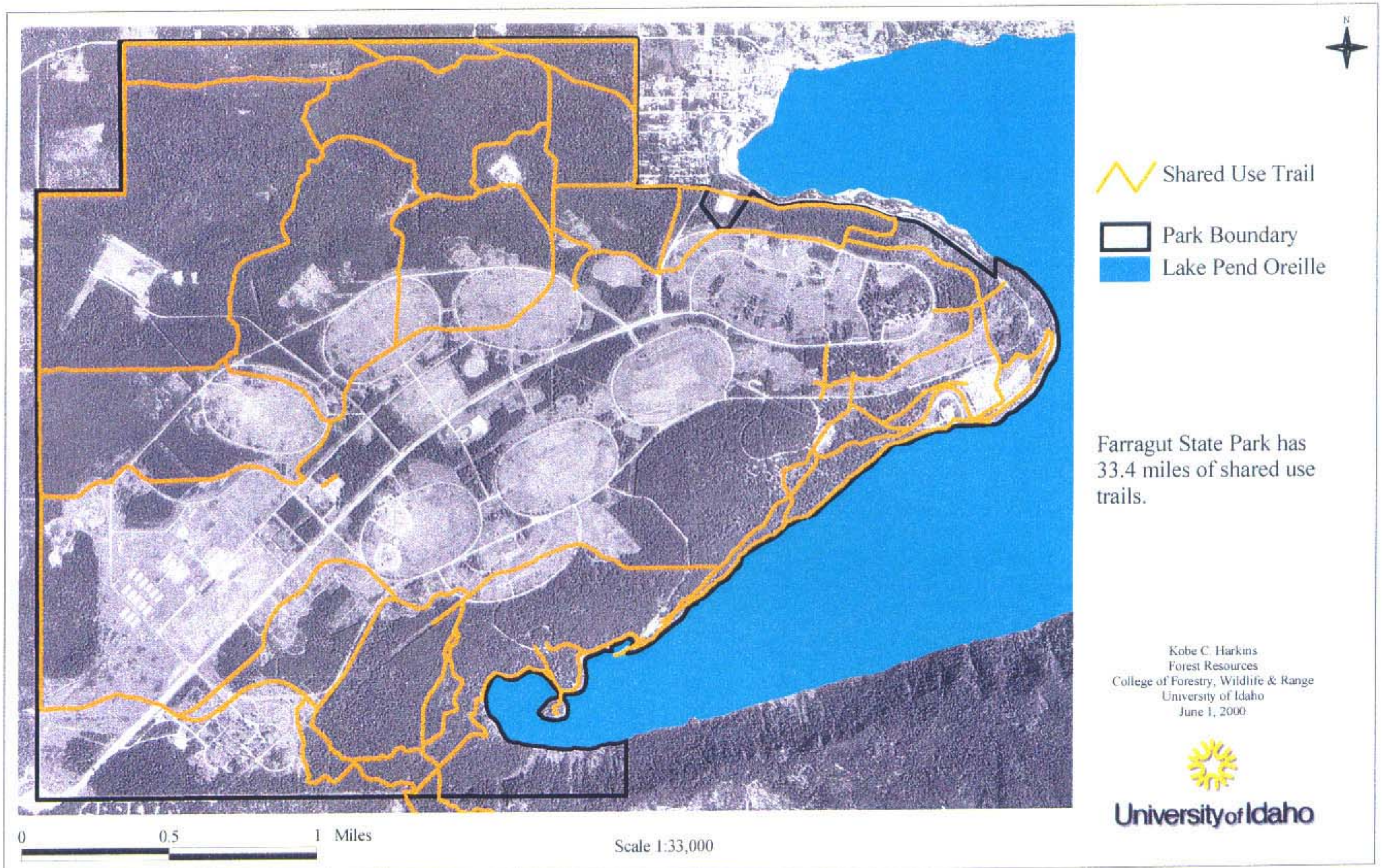

Figure 16. Farragut State Park has a shared use trail system that is used by nature walkers, hikers, horseback riders, bicyclists, and cross country skiers.

CHAPTER 3: NATURAL RESOURCE MANAGEMENT – ISSUES, CONCERNS, AND MANAGEMENT PRESCRIPTIONS

I. PONDEROSA PINE MANAGEMENT

Historical range of variability (HRV) identifies an ecosystem's amplitude of historical succession processes to disturbances over time. It is used to identify an ecosystem's resistance and resilience mechanisms. Hence, the type and frequency of disturbance patterns prior to settlement by Euro-Americans provides a management guide for maintaining ponderosa pine forests within their historical range of variability (Neuenschwander 1995). Historically, open ponderosa pine (*Pinus ponderosa*) forests dominated the southeast to west facing slopes within Farragut State Park. Non-lethal surface fires burned through these forests at a 13-20 year interval. The use of HRV helps ensure that resistance and resilience mechanisms are functioning within ponderosa pine forest ecosystems (Steele and Geier-Hayes 1995). The HRV strategy requires historic forest structures, forest compositions, and fire regimes be simulated in the ponderosa pine forests of Farragut State Park. The following objectives help to restore these components to ponderosa pine ecosystems:

- Create an open forest structure by reducing tree densities and basal area
- Reduce forest floor organic matter
- Reduce seedlings and saplings of shade-tolerant species
- Maintain lush herbs and shrubs in the forest understory
- Increase ponderosa pine regeneration in open forest patches by removing organic matter and exposing mineral soil seedbeds
- Increase habitat for wildlife species suited for open ponderosa pine forests

A. PRESCRIBED BURN AREAS AND HARVEST/PRESCRIBED BURN AREAS WITHIN FARRAGUT STATE PARK

The restoration of dense ponderosa pine forests requires identification of existing and potentially dominant ponderosa pine forest patches. After determining what areas require restoration, techniques can be devised for implementing restoration efforts. A GIS suitability analysis was conducted to determine areas suitable for prescribed burning and areas requiring improvement thinning or clear-cuts before prescribed burning. Community types, habitat types, and aspects capable for supporting ponderosa pine (*Pinus ponderosa*) forests were selected from GIS maps. The suitability data was then combined in an overlay analysis. The suitability parameters used in the analysis were the following:

Community types:

- Ponderosa pine and Douglas-fir mix (all canopy cover densities)

- Ponderosa pine, Douglas-fir, and Grand fir mix (all canopy cover densities)

Habitat types:

- Douglas-fir (*Pseudotsuga menziesii*) / ninebark (*Physocarpos malvaceus*)-ninebark
- Douglas-fir / ninebark-false starry-eyed Solomon's seal (*Smilacina stellata*)
- Grand fir (*Abies grandis*) / ninebark-ninebark
- Grand fir / queenscup beadlily (*Clintonia uniflora*)-ninebark

Aspects:

- Southeast
- South
- Southwest
- West

The suitability analysis resulted in a restoration area (Figure 17) totaling 732 acres. Restoration areas consisted of 3 major plant cover types: dense ponderosa pine forests, sapling forests, and spotted knapweed communities (Figure 7). The ponderosa pine forests and sapling forests require thinning and prescribed fire, while the spotted knapweed areas are designated for seedling planting. All restoration areas will require intense management for spotted knapweed.

B. THINNING STANDARDS

The return of fire into dense fire suppressed forests could fatally damage overstory ponderosa pine trees. Harvesting is required in dense stands to decrease tree stress, fire damage and crowning potential. Harvesting reduces tree density, removes shade tolerant species, and provides light to decadent shrubs and herbs (Harrington 1996). Ponderosa pine forests commonly had basal areas $\leq$ 100 ft^2 per acre prior to 1900 (Fiedler 1996). Fiedler (1996) recommends reserve basal areas of 40-60 ft^2 per acre for young, uneven-aged patches to ensure regeneration of ponderosa pine, while higher basal areas can be maintained in old-growth patches. The reserve density or basal area for ponderosa pine forests in Farragut State Park will be between 30-100 trees per acre or $\leq$ 100 ft^2 per acre basal area. These targets can be achieved in the first or second silvicultural entry. The most important priority of all these treatments is the protection of old-growth ponderosa pine trees. Old trees (leave trees) need to remain in all areas regardless of their condition. Restoration units may require more than one entry if slash loads are > 20 tons per acre.

C. LEAVE TREES AND SNAGS

Leave trees are live trees that remain within the restoration areas and that are protected from damage during logging and prescribed burning operations. Leave tree density and basal area will simulate presettlement ponderosa pine forests (30-100 trees per acre and basal area $\leq$ 100 ft^2 per acre). The large diameter trees generally survived historical wildfires and will be maintained within the restoration areas. Large ponderosa pine and western larch $\geq$ 20 inches and Douglas-fir $\geq$ 25 inches need to be left. Douglas-fir < 25 inches and all grand fir will be removed from the restoration site. Ponderosa pine and western larch in the 0-10 inch size class will also be removed, unless they occupy a regeneration gap in the forest. If the forest density or basal area is still above the restoration standard (30-100 trees per acre or < 100 ft^2 per acre), Douglas-fir in the > 25 inch size class followed by ponderosa pine and western larch in the 10-20 inch size class will be thinned. Managers need to start at the lower size classes and work there way up the diameter class scale until they reach the designated stocking level. Unique trees of any species with special morphology (deformed stems, forked stems and tops, deformed tops,etc.) should also be maintained in the restoration areas for wildlife. The prescription for each restoration unit should be reviewed and field checked before treatment.

The protection of leave trees and snags is dependent on their size and spacing and their proximity to heavy dead fuels and tree regeneration. Leave trees need special protection when total fuels exceeds 30 tons per acre and when less than 3 inch diameter fuels exceed 10 tons per acre. Fuels need to be moved at least 6 ft from around the tree base, and not placed on the side slopes of the leave tree. Deep duff and litter beds > 4 inches need to be scraped away from the bases of leave trees (Kilgore and Curtis 1987). A second alternative is to remove a portion of the duff layer by prescribed burning around the trees in early spring when snow is still on the ground. The wet fuel conditions prevent the complete removal of the duff layer and subsequent cambium damage. Heavy fuel piles add to fire intensity and normal air updrafts scorch crowns of trees uphill from these fuels. Ladder fuels near leave trees need to be reduced to 2 ft or less and tops need to be kept away from the downhill side of leave trees. Slash depths need to be limited to 3 ft and not placed under crowns of leave trees. Predicted fuel loadings > 35 tons per acre result in flame lengths that cause excessive scorch damage. In order to lower crown scorch, jackpot burns of heavier fuels are conducted and then followed by broadcast understory burning of lighter fuels (Kilgore and Curtis 1987). All existing snags should be left standing. Prescribed fire will consume some existing snags, but will create others by killing trees (Horton and Mannan 1988).

D. HARVESTING SYSTEMS

The factors that impose limitations on harvesting in Farragut's ponderosa pine forests are soil moisture, park roads and trails. Silt loams are the majority of the soil types (Kootenai-Bonner complex, Kootenai cobbly silt loam, and Kootenai gravelly silt loam) within the harvest areas (Weisel 1980). Slope is the dominant factor separating soils into ground based skidding or cable yarding systems. Slope was added to the analysis in order to determine the type of harvesting system appropriate for the restoration units (Figure 5). Areas with slope $\leq$ 35% require ground based skdding equipment or intermediate support yarding technology, while slopes > 35% require the use of cable yarders (Heinrich 1985b, Letourneau 1984). The use of these systems in the appropriate areas minimize soil loss (Lousier 1990). All of the restoration area is on slopes $\leq$ 35%. The analysis determined that all of the restoration area is < 35%.

The second critical factor influencing harvesting techniques is soil moisture, which determines the time of harvest (season) and the type of harvest system. The silts and silt loams in the park demonstrate a high potential for soil compaction and erosion, especially when wet. The surface runoff and erosion on soils with slopes $\leq$ 35% are medium to high (Weisel 1980). Hence, harvesting should be done on dry soils or on frozen ground covered with snow (Trzesniowski 1985b, Lousier 1990). Winter harvesting cannot be conducted during mild winters due to the lack of snow and the shallow freezing depth of the soils. Consequently, it is only allowed in late summer and fall when soils are dry and during cold winters with a deep snowpack. Soils must be frozen to at least 6 inches in depth (Lewis and Timber Harvesting Subcommittee 1991). Managers need to use care in designing restoration prescriptions due to wet conditions and soil compactibility.

Skid trail construction must be pre-planned and minimized in order to diminish the area impacted by ground based vehicles. Skid trails require spacing as far apart as possible to reduce soil displacement and compaction. Spacing depends on the average extraction distance of harvesting equipment. The terrain will determine the type of harvesting equipment usable in a restoration unit. A maximum skid trail spacing is required regardless of the harvesting equipment used in a restoration unit. In additon, skid trail width needs to be minimized to $\leq$ 12 ft. Cut and fill skid trails are not permitted, unless they can be used as a trail. Water bars need to be built before the rainy season or after logging has been completed to prevent gully erosion (Heinrich 1985a). Log landings should be located on existing roads with slopes ranging from 0-15%. The landings are required to be $\leq$ 1 acre in size, except where larger areas may be utilized within the park development plans (Lewis and Timber Harvesting Subcommittee 1991).

Ground based harvesting equipment will be restricted from leaving the skid trail network (Bradshaw 1979, Olsen and Seifert 1984, Froelich et al. 1991). Low ground pressure equipment is recommended for skidding, forwarding and delimbing (Trzesniowski 1984a). Harvesting systems need to be designed, so that a vehicle passes only once or twice over a road (Lewis and Timber Harvesting Subcommittee 1991). The use of existing roads is highly recommended, but new roads may need to be built if some of the restoration areas are not reachable with the existing roads. Intermediate support yarding technology used on gentle terrain might be an alternative for areas with no or few roads (Shaffer 1992, Osborne 1994).

The log length harvesting system is required for thinning in Farragut State Park (Egger 1984, Trzesniowski 1985a). The log length harvesting system helps reduce the amount of damage to leave trees. The felling direction of trees will be determined by the harvest system used on a restoration unit. Felling needs to be conducted in a manor which minimizes the damage to cut and standing trees (Trzesniowski 1985a). Limbing and topping in the harvest area will occur prior to skidding of logs. Residual tree limbs and tops will be left in the harvest area in order to retain nutrients at the site. Logging slash will also be left dispersed across the restoration unit and not piled (Food and Agriculture Organization 1977). The restoration unit will be prescribed burned after harvest or as soon as safe burning conditions are available. Prior to burning, heavy slash loads will be pulled away from the bases of leave trees and snags (Kilgore and Curtis 1987).

E. PRESCRIBED BURNING

Prescribed fire in a ponderosa pine ecosystem is used to simulate historical low intensity fires (Biswell 1977). It also attempts to restore ponderosa pine ecosystems to their historical fire regime by reducing fuel accumulations, decreasing fire spread rate, modifying forest structure, removing ladder fuels, killing small trees, and decreasing fuel continuity (Arno et al. 1995a, Harrington 1996). Fire suppression allows fine and coarse woody fuels to accumulate in ponderosa pine ecosystems. Consequently, the first application of fire into a restoration site needs to be done carefully, due to the high fuel loads caused by fire suppression. Biswell (1960) recommends reintroduction of fire over several burn cycles. The first use of prescribed fire on a restoration site can remove a substantial percentage of fuels. Prescribed burning after a first entry will have to contend with the residual from the first entry and the ground and surface fuels that accumulate annually. It may take 3 to 4 prescribed burns in order to get a ponderosa pine site back into a pre-settlement condition. The removal of fine and intermediate fuels < 1 inch from the fuel complex reduces the rate of fire spread through ponderosa pine forests (Rothermel 1983). The removal of these fuels also reduces the fuel depths, which reduces the amount of cambium damage to individual trees (Neuenschwander 1995). Presently, the density of these fuels, especially after harvesting, may require jackpot burning, especially if red slash loads are high, in order to reduce the intensity of fire on treatment sites (Sackett 1980, Deeming 1990, Agee 1993).

Prescribed burning can be conducted in the Fall immediately after selective logging and in the Spring before bud break (usually in March). The timing of these burns will be dependent on moisture and weather. Moisture differentials between the burn unit and adjacent lands is important for containment of the prescribed fire (Neuenschwander 1995). Moisture of extinction, differences in soil and fuel moisture, solar radiation, temperature, relative humidity, and fuel availability will be used to identify unit boundaries. The moisture of fuels determines whether they are available for burning. Patchy available and unavailable fuels creates a discontiuous fuelbed. The discontinuous fuelbed confines prescribed fires to treatment areas and can be used to delineate proposed prescribed fire boundaries. If the majority of fuels are available for burning in the treatment area and adjacent areas, then firelines may be required in order to conduct a safe burn. Natural barriers, roads, trails and waterways should be used first if firelines are needed for a prescribed burn. The fire history in the park demonstrates a fire interval of 15 $\pm$ 5 years and prescribed fires should approximate this interval. Prescribed burning will also be accelerated in certain restoration areas to promote the conversion of shrubs to grasses. Several prescribed fires may be required to return ponderosa pine forests to their historical range of variability.

F. SMOKE MANAGEMENT

Prescribed fire smoke declines with dilution and emission-reduction strategies

(Mathews et al. 1985). Dilution reduces smoke by lowering the smoke concentrations through a greater volume of air, while the emission-reduction strategy reduces smoke by minimizing the smoke output per unit area treated. Dilution is achieved by burning under unstable atmospheric conditions, at slower rates and by burning smaller areas. The emission-reduction strategy is successful with proper scheduling of prescribed burns (e. g., duff and large fuels are wet and lower smoke emissions) and effective firing techniques (Mathews et al. 1985). The Farragut State Park fires will minimize smoke by burning under unstable atmospheric conditions, moist fuel conditions and by using the appropriate ignition pattern where applicable. Maintaining small burn units will also reduce the amount of smoke emitted by Farragut State Park.

G. MANAGEMENT OF BARK BEETLES WITH IMPROVEMENT-CUTS, CLEAR-CUTS AND PRESCRIBED FIRE

With the practice of fire suppression, Douglas-fir and grand fir have increased in dominance in historic ponderosa pine communities. The present state of ponderosa pine forests in Farragut promotes conditions for outbreaks of all these insects. The usual progression of root disease in Douglas-fir trees is from chronic root loss lasting decades to critical root loss (>70% of main roots). Douglas-fir beetle attacks on Douglas-fir and grand fir will follow and may be followed or concurrent with Douglas-fir pole beetle attacks in the upper stem of the tree. In grand fir, fir engraver may attack at the top of the tree. In severly stressed forests, Douglas-fir beetles may spill over to nearby trees. Douglas-fir beetle infestations are related to root disease 92% of the time. Dying trees, downed trees or slash are usually attacked by Douglas-fir pole beetle. However, when root disease reaches critical mass, Douglas-fir pole beetle may be predominant in the lower stem and Douglas-fir beetle absent. In the Inland Northwest 97% of fir engraver attacks are associated with root problems, particularly disease caused by root-rot fungi. Brown stain (*Trichosporium symbioticum*) is carried by this beetle and is essential for a successful attack (Bertagnolli and Partridge 1994).

Ponderosa pine is susceptible to western pine beetle, mountain pine beetle, and pine engraver. Pine engraver beetles build up in slash or downed trees and spill over to kill surrounding trees. Dry weather predisposes trees to attack by this beetle. Western pine beetle almost always is associated with root disease or other causes of severe stress and typically attacks trees jointly or successively with pine engraver and other *Dendroctonus* species. Western pine beetle is a natural predator of ponderosa pine. However, root disease and stress from high forest densities has made these trees even more susceptible to beetle attack. Mountain pine beetles develop from endemic populations and attack weak trees when natural checks or ecosystem dynamics permit. Natural checks include sub-zero weather, parasitic nematodes, predaceous insects, parasitic fungi, and woodpeckers. Often the populations of predators and parasites fluctuate with beetle populations. When populations are endemic, these beetles attack the weak trees, but when populations are epidemic they affect all trees, including the most healthy. Successful attacks by mountain pine beetle depend on the presence of stain fungi which protect the beetle brood from pitch-out . *Europhium clavigerum* and

Ceratocystis montia are common associates carried by and utilized by these beetles (Bertagnolli and Partridge 1994).

Fire restoration in the ponderosa pine forests of Farragut State Park is the most effective treatment for all of these insects. Douglas-fir establishment in ponderosa pine forests increases tree densities above historical densities (< 100 trees per acre). Competition for water and other resources stresses trees in these dense forests and lowers tree vigor. Trees become even more susceptible to root rots and beetle attacks. Dead trees provide slash that add to fuel loads and provide additonal habitat for bark beetles. Thinning of the young Douglas-fir reduces stress in the remaining trees and makes them less susceptible to attack. Prescribed burning removes slash and reduces bark beetle habitat. The timing of thinning and prescribed burning is important. Slash present on treatment sites during the spring and early summer in dry years can lead to pine engraver and western pine beetle outbreaks (Bertagnolli and Partridge 1994). Managers need to remember that forest insects and diseases are a natural component of forests and have a long evolutionary history with forest ecosystems. Fire restoration treatments are not designed to eliminate forest insects and diseases! The goal is to align insects and diseases with a fire regime that allows ponderosa pine forests to maintain and perpetuate themselves.

H. PROTECTION OF SENSITIVE SPECIES AND ENHANCEMENT OF WILDLIFE HABITAT

The use of prescribed fire can be either positive or negative to some species and communities (Bendell 1974). Information of fire effects is especially important when managers are dealing with rare and endangered species and communities. The locations of species and communities that require fire versus those that are degraded by fire need to be identified before a prescribed burning program can be implemented. The identification of these locations is necessary for the protection or enhancement of wildlife species.

For example, the pygmy nuthatch (*Sitta pygmaea*) is listed by the Conservation Data Center (CDC) of the Idaho Fish and Game Department (1994) as rare or uncommon (21-100 occurrences) but not imperiled in the State of Idaho. This species prefers open ponderosa pine communities (Burleigh 1972). The restoration of ponderosa pine in Farragut State Park would provide additional habitat for this species. Our analysis using the database determined that the restoration of ponderosa pine communities within Farragut State Park would increase pygmy nuthatch habitat up to 732 acres (Figure 17). Restoration of ponderosa pine forests benefits the pygmy nuthatch. However, restoration could also be detrimental to other rare, threatened or endangered species.

Least bladdery milkvetch (*Astragalus microcystis*) and black snakeroot (*Sanicula marilandica*) populations in Farragut State Park also are of concern. The Idaho Native Plant Society lists least bladdery milkvetch as taxa in danger of becoming extinct or extirpated from Idaho in the foreseeable future if ponderosa pine habitat continues to be degraded or depleted. The Conservation Data Center lists black snakeroot as imperiled because of rarity or because other factors make it very vulnerable to extinction. Fire adaptations have evolved with the milkvetch, but not with black snakeroot. Prescribed burning would be detrimental to the later species. The Farragut State Park GIS database provides the locations of the least bladdery milkvetch, black snakeroot, and proposed fire restoration areas. Location information provides areas of species and prescribed burning overlap, which allows managers to protect sensitive species by redefining prescriptions and management goals. GIS analysis revealed an overlap between least bladdery milkvetch and black snakeroot habitat and the proposed fire restoration areas (Figure 18). Least bladdery milkvetch is use to the frequency of fire in ponderosa pine forests. Prescribed burning prescriptions need to be designed to promote least bladdery milkvetch survival and reproduction and to prevent fire escapes from negatively affecting black snakeroot populations.

II. WILDFIRE HAZARD AND RISK MANAGEMENT: PROTECTING PEOPLE AND PARK FACILITIES

Urban wildland intermix problems exist anywhere a wildfire spreads from native vegetation to structures or vice versa. The risk of destructive wildfires is high to structures in high fuel areas. Dense shrubs and tree patches around structures are of great concern to park structures. Transportation and utility corridors passing through areas with high fuel loads are also of concern due to a greater probability of a fire ignition. The Farragut State Park GIS database was able to determine these high fuel hazard areas within the park (Figure 10). Fires near structures, power lines, roads, and trails in a fuel model 1, 2 or 2/8 will have fast rates of spread. Fires in a fuel model 10 are more intense and have a greater chance of crowning and torching. Fires in fuel model 8 are usually of less concern. Risks to people and property can be reduced by reducing fuels in the high risk areas.

Fuel breaks are an effective strategy for saving structures. Vegetation management can reduce flammable vegetation around homes and create a fuel break between wildland vegetation and structures (Hummel 1990). The greater the width of a fuel break, the greater the protection to the structure. This fuel break can be used by firefighters to protect structures, while the absence of it makes firefighting difficult due to high heat intensity, flame height, and rate of fire spread.

Fuel break strategies include fuel removal, fuel reduction, and vegetation type conversion. Fuel removal consists of clearing vegetation around structures, so that fuel is not consumed by wildfire. Fuel reduction is the partial removal of plants and consists of two strategies. Strategy one involves removing highly flammable species and retaining more fire resistant species. The resistant species require periodic cleaning, thinning, and pruning to reduce dead material volume. Strategy two is to reduce fuels by removing a portion of all plants. The reduction of burnable plants reduces flame length, fire intensity, and the rate of fire spread. Vegetation type conversion consists of removing plants and then replacing them with lower growing, less flammable species. Low growing plants reduce the flame heights of a wildfire. Fuel removal and fuel reduction strategies can be used around existing and future structures in Farragut State Park.

A fuel removal and fuel reduction strategy requires a fuel break of > 30 ft radius around structures. Fuel breaks < 30 ft are susceptible to radiant heat and spotting. Large fuel breaks reduce the spread of fire from plants to the structure or vice versa. Fire resistant trees and shrubs are acceptable within this zone (Hummel 1990). Characteristics of fire resistant vegetation consist of the following:

- Plants that have little or no accumulation of dead biomass
- Non-resinous plants (willow, popular, maple or alder trees)
- Low volume vegetation (open forest)
- Plants with high live fuel moisture (plants contain a large amount of water in comparision to their dry weight)
- Drought tolerant plants (deeply rooted plants with thick, heavy leaves)
- Absence of ladder fuels (pruned trees and well spaced trees)
- Plants requiring little maintenance (slow growing plants)
- Woody plants that require prolonged heating to ignite

If possible, homeowners should have 20 ft or more space between individual trees and large shrubs. Trees and shrubs require the creation of openings between their canopies and require pruning to a minimum height of 10 ft of the ground for trees (Hummel 1990). Tall, dry grass should be mowed. The area within 10 ft of a propane tank should be kept clear of debris and litter. Chimneys must be cleared of tree limbs for a minimum distance of 10 ft (Hummel 1990). Fuel volumes need to be kept below the fuel volumes of the surrounding forest (Hummel 1990). A second fuel break is recommended beyond the 30 ft zone. The objective of this zone is to reduce flammable plants and dense ground fuels. It should extend at least 100 feet beyond the outer perimeter of the first zone. Fuels also need to be managed along roads that have a high fuel hazard. Ground fuels need to be removed from within 50 ft of these roads. Reduction of flammable plants and ground fuels lower fire intensity and flame heights, and reduces the rate of fire spread as it approaches the 30 ft diameter fire break and the structures within it. These fuel breaks require constant management.

The best and final strategy for protecting structures and facilities in Farragut State Park is the restoration of fire into the ponderosa pine forests. Treatment of these forests breaks up the landscape fuel continuity and reduces rate of spread, intensity, and crowning potential of wildfires in the park. The reduced fire potential slows the approach of wildfire toward structures and helps firefighters in their suppression efforts.

III. WESTERN WHITE PINE RESTORATION

Western white pine (*Pinus monticola*) requires the maintainence of old-growth patches and the restoration of areas where it was once abundant. Traditionally, clear-cuts, seed-tree cuts, and shelterwood cuts have been conducted in western white pine forests. Occassionally, prescribed fire was also applied after harvesting (Haig et al. 1941). These treatments provide suitable sites for white pine regeneration. However, they also disturb soils and provide suitable habitat for currant germination. Consequently, white pine blister rust (*Cronartium ribicola*) thrives on highly disturbed sites (Hagle et al. 1989). Restoration at a small scale (root rot pockets and windthrow areas) may diminish large scale soil disturbance and currant establishment.

Individuals within the western white pine population have genetically derived physiological mechanisms that make them resistant to white pine blister rust infection. The U. S. Forest Service started a nursery program to capture these genetic traits. The program sampled 3,000 indivdual trees and created white pine seedlings with several types of rust resistant seedlings. The goal of small scale restoration is to conserve a rust-resistant gene pool that can maintain itself after major disturbances like wildfire. Small scale restoration is also more aesthetically pleasing in a park setting. The procedure for western white pine restoration within Farragut State Park is the following:

- Determine the geographic distribution of western white pine within the park
- Locate root rot gaps and other natural forest openings
- Increase the abundance of resistant western white populations by planting in these natural forest openings.

A. WESTERN WHITE PINE DISTRIBUTION WITHIN FARRAGUT STATE PARK

The potential distribution of western white pine within Farragut State Park was determined by overlaying habitat type (Cooper et al. 1991) and community type maps. The composite map resulted in a 2101 acres area designated as suitable western white pine habitat (Figure 15). A small portion of the restoration area, 45 acres, may be suitable for ponderosa pine restoration and needs to be surveyed before restoration work can begin (Figure 15). Suitable habitats provide conditions that allow the species to successfully reproduce, grow and survive. Western white pine seedlings will be planted within the suitable habitat areas of Farragut State Park.

B. PLANTING OF WESTERN WHITE PINE

Natural openings in the forest canopy will be used to plant western white pine seedlings within the suitable habitat areas. Ground reconnaissance and current aerial photographs are required to locate canopy openings. The resistant seedlings will be planted within existing canopy openings that do not contain visible currants. Seedlings need to be planted in the spring (Graham 1990) and will be planted at a density of 30 saplings per acre. Western white pine is a moderately shade intolerant species and requires the sunlight provided by these gaps.

Western white pine establishment in forest openings is negatively affected by currants, temperature, moisture and sunlight. Blister rust requires currants, extended periods of moderate temperatures ($< 67^0$ F), and moisture on the needle surfaces in order to infect the pines. These temperature and moisture conditions are required in the late summer to early fall when the rust is producing teliospores on currant leaves. Forest canopy openings serve as areas for dew formation and cool air sinks. They provide the rust the moisture and temperatures required for infection of western white pine (Anderson 1973). The openings also provide sunlight to maintain currants. However, it is unclear how rust-resistant seedlings will do in canopy openings. We hope the absence of currants in planting areas and the genetic makeup of planted seedlings will negate the negative conditions of forest openings.

Genetic resistance is the primary mechanism for protecting western white pine from white pine blister rust. In addition, planting rust-resistant white pine with temporal and spatial variation expands this resistance to a larger land area (Nance 1986). Planting at a landscape level increases the available rust-resistant genes for areas disturbed by fire. It also provides a future gene pool for white pine resistance programs (Gerhold et al. 1986).

IV. NOXIOUS WEEDS: PRESENCE AND MANAGEMENT

Noxious weeds in Idaho alter fish and wildlife habitat, out compete native plant species, create fire hazards, poison livestock, destroy agricultural crops, and impact the biodiversity of parks and natural areas (Callihan and Miller 1994). Certain weeds within the state are designated noxious by law (Nelson 1991, Callihan and Miller 1994). Weeds are designated noxious by the following criteria: 1. The weed must be present in Idaho, but not native to the state. 2. It must be potentially more harmful than beneficial. 3. A sufficient plan for its control (economic, physical, and biological) must be on file at the Idaho Department of Agriculture. 4. The potential adverse impact of the weed must exceed the cost of control.

Farragut State Park resides within Kootenai county. There are 13 noxious weeds present within the county:

- Field bindweed
- Scotch broom
- Meadow hawkweed
- Orange hawkweed
- Poison hemlock
- Diffuse knapweed
- Spotted knapweed
- Rush skeletonweed
- Leafy spurge
- Canada thistle
- Scotch thistle
- Dalmatian toadflax
- Yellow toadflax

Highways, roads, railroads, horse trails, and hiking trails are the main areas impacted by these weeds. All noxious weed species within Farragut State Park can be treated with herbicides and some with biological controls or specialized treatments. Field bindweed, for instance, can also be treated by tilling the soil 2 weeks after the plant emerges. Tillage is repeated every two weeks during the growing season over the next 2-3 years. Meadow and orange hawkweeds can be suppressed by applying herbicides in the early spring and then applying nitrogen fertilizer. The fertilizer helps grass species compete with the weeds. In order to control rush skeletonweed, herbicides need to be applied consistently for 3-5 years. Sheep and goats have been used to stop the spread of leafy spurge. Finally, herbicide use on scotch thistle needs to focus on very small plants in order to be successful.

The types of herbicides available for treatment are extensive and it is impossible to recommend one type. I recommend the PNW Weed Control Handbook to assist managers with herbicide selection. The handbook includes recommendations for the use of most herbicides. The handbook is available through the College of Agriculture at the University of Idaho. It is only valid for one year and a new issue is written every winter to account for changes in laws, research, and treatments. Secondly, the county extension agent, weed superintendent's office, or the University of Idaho Weed Diagnostic Laboratory can provide you with additional information.

Several biological control agents ranging from flies, moths, beetles, midges, mites, weevils, and rusts are used to control the following noxious weeds (Nelson 1991, Callihan and Miller 1994): poison hemlock (*Conium maculatum*), spotted knapweed (*Centaurea maculosa*), rush skeletonweed (*Chondrilla juncea*), Canada thistle (*Cirsium arvense*) and yellow toadflax (*Linaria vulgaris*). Use of biological control agents by themselves on these species may not satisfy Idaho's noxious weed law. Specific information on biological controls and life histories of noxious weeds are available in <u>Idaho's Noxious Weeds Guide</u> (Callihan and Miller 1994) or <u>Undesirable Weeds of Idaho Forest Lands</u> (Nelson 1991).

The most abundant noxious weed in Farragut State Park is spotted knapweed. There is 1,357 acres of vegetation dominated by this species, which composes 34 % of the park (Figure 7). Treatment of this noxious weed needs varies depending on the patch size. Small patches can be treated and eliminated with a persistent herbicide program. Large patches require cultural and biological treatments along with herbicides. Annual treatments will slow the spread of the plant and will eventually reduce its abundance in the park. Treatment programs need to be long-term due to the longevity of the spotted knapweed seed. The longevity of knapweed seed is 12 years (Lacy 1985). Consequently, control programs need to last until the seed reserves are eliminated from the park.

There are two commonly recommended herbicides used to control spotted knapweed on rangelands: picloram (Tordon), 2, 4-D and dicamba (Banvel). These herbicides select for broadleaf weeds and generally do not harm grasses. However, these herbicides can harm trees and they need to be examined for their effects on conifer seedlings and saplings. The herbicides need to be applied in late May to early June when the plants start sending up seed stalks.

The infestation of spotted knapweed is extensive in Farragut State Park. We recommend the use of biological weed controls. Biological weed control is the deliberate use of natural enemies of a weed to reduce weed densities to an acceptable level. The advantages of biological controls are that they are self-perpetuating once established and more target specific. Five biological controls of spotted knapweed have been introduced to North America from Eurasia: two flies (*Urophora affinis* and *Urophora quadrifasciata*), moth (*Metzneria paucipunctella*), root-mining beetle (*Sphenoptera jugoslavica*), and two root-mining moths (*Agapeta zoegana* and *Pelochrista medullana*). *Urophora affinis* is a seed head-attacking fly that deposits its eggs inside the knapweed flower bud in early June. The larvae feed inside the flower head through the summer and cause the plant to divert energy from seed production to forming a gall around the larvae. *Urophora quadrifasciata* is similar to the seed head-attacking fly, but produces two generations a year and attacks older flower heads. These flies compliment each other and can cause up to 95% seed reductions. The moth feeds on the florets and seeds of spotted knapweed, while the larvae of the two root-mining moths feed on the roots of small rosettes. The root-mining moths usually kill the plant. The effects of the root-mining beetle are unknown at this time. The seed head-attacking fly is the only one available to the general public. Further information can be obtained from the Western Agriculture Research Center in Corvallis, Oregon or from the Kootenai County agriculture agent.

Prescribed fire by itself is not an option for spotted knapweed control. Small patches of knapweed are left after a fire and the fires are usually not hot enough to eliminate all of the viable seed reserves or to prevent crowns from re-sprouting. Prescribed fire may be used in combination with herbicides. Fire removes litter and stimulates new growth plant growth. Managers can treat this new growth with herbicides. Other potential solutions to controlling spotted knapweed are eliminating public access and vehicle use in infested areas and seeding disturbed sites with perennial grasses.

V. VISITOR USE AREAS: VISITOR IMPACTS AND MANAGEMENT

Soil compaction in the residential, commercial camping, commercial day use, and developed day use zones are the results of automobiles, recreational vehicles, park maintainence equipment (tractors, mowers, etc.), and foot traffic. The most heavily impacted areas are campgrounds. Soil compaction, root diseases entering wounded tree roots, and the trampling of seedlings by park visitors are the cause of high tree mortality in these areas. High tree density is another possibility of increased tree mortality in visitor areas (Arno et al. 1995, Fiedler 1996).

Black cottonwood (*Populus trichocarpa*), paper birch (*Betula papriferya*), ponderosa pine (*Pinus ponderosa*), western larch (*Larix occidentalis*), and western white pine (*Pinus monticola*) are possible trees which can be planted on compacted soils. The tree species planted will depend on the habitat type for each site (Figure 8). Mixtures of seedlings is recommended in order to determine the best species for a site. Surveys of tree vigor on each site will determine which species to plant. In additon, the restoration plans for ponderosa pine and western white pine incorporate many of these visitor areas. These plans can determine which areas need to be planted with ponderosa pine or western white pine.

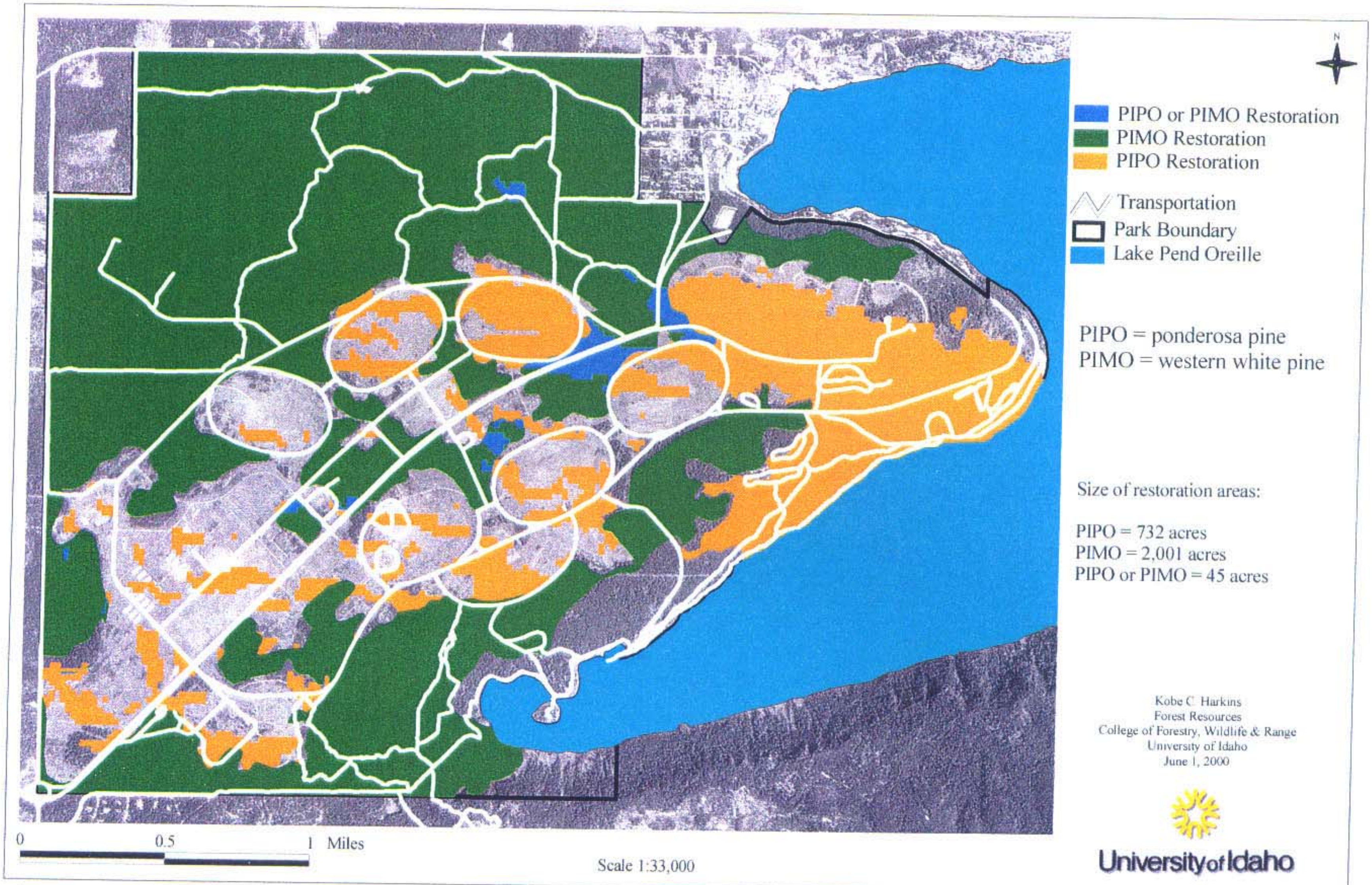

Figure 17. Farragut State Park has the potential to develop restoration programs for ponderosa pine and western white pine.

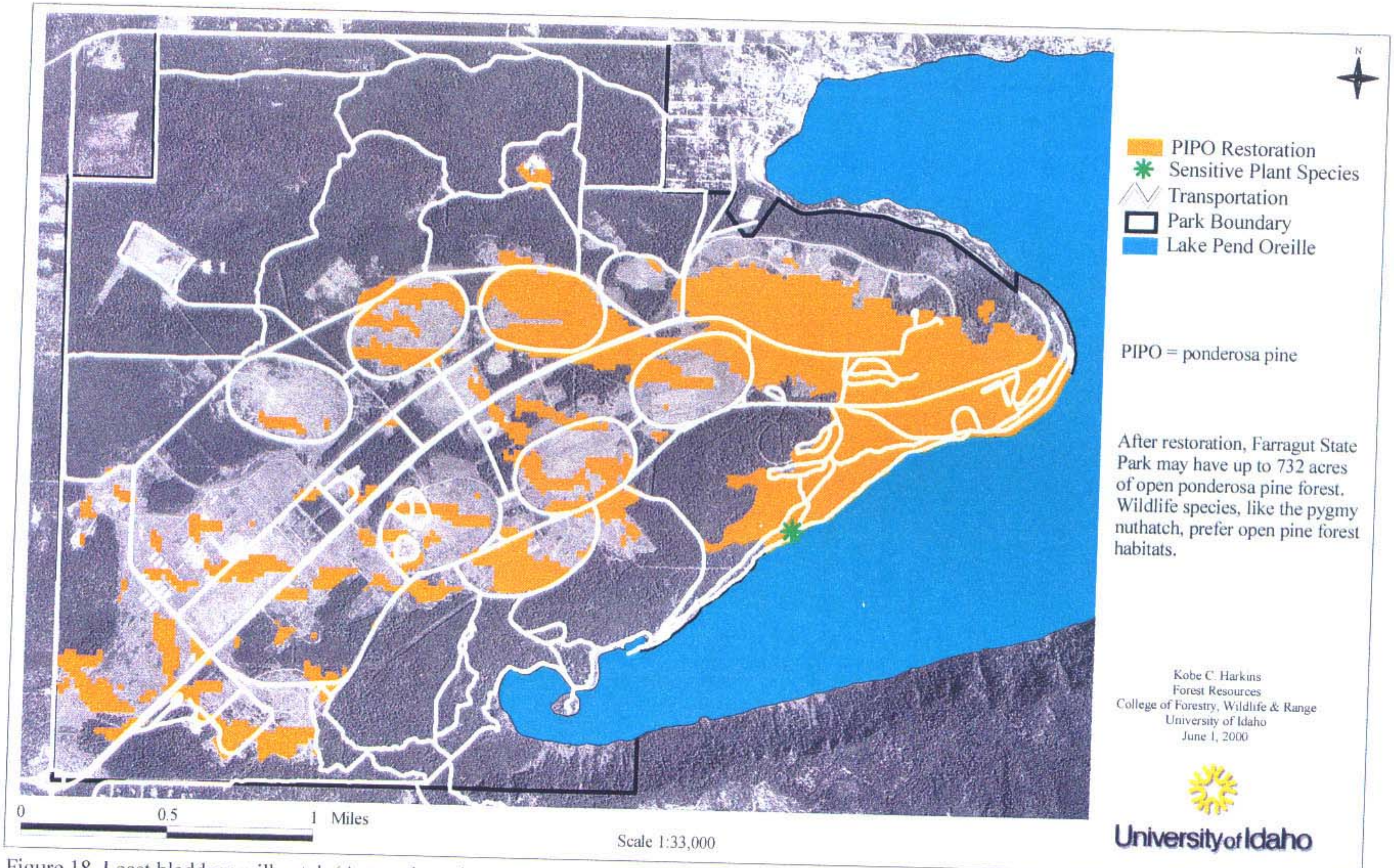

Figure 18. Least bladdery milkvetch (Astragalus microcystis) and black snakeroot (Sanicula marilandica) are located within the ponderosa pine restoration area. Restoration areas will provide additional habitat for species that prefer open ponderosa pine forests.

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APPENDICES

APPENDIX A: EXISTING AND POTENTIAL PLANT SPECIES WITHIN FARRAGUT STATE PARK

TREES

Grand Fir (*Abies grandis*)*
Subalpine Fir (*Abies lasiocarpa*)
River Birch (*Betula occidentalis*)
Paper Birch (*Betula papyrifera*)
Western Larch (*Larix occidentalis*)
Engelmann Spruce (*Picea engelmanii*)
Lodgepole Pine (*Pinus contorta*)
Western White Pine (*Pinus monticola*)
Ponderosa Pine (*Pinus ponderosa*)*
Douglas-fir (*Pseudotsuga menziesii*)*
Western Redcedar (*Thuja plicata*)*
Western Hemlock (*Tsuga heterophylla*)*
Mountain Hemlock (*Tsuga mertensiana*)

SHRUBS

Rocky Mountain Maple (*Acer glabrum*)*
Sitka Alder (*Alnus sinuata*)
Western Serviceberry (*Amelanchier alnifolia*)*
Redstem Ceanothus (*Ceanothus sanguineus*)
Mountain Balm (*Ceanothus velutinus*)
Red-osier Dogwood (*Cornus stolonifera*)
Black Hawthorn (*Crataegus douglasii*)
Ocean-spray (*Holodiscus dicolor*)*
Utah Honeysuckle (*Lonicera utahensis*)
Fool's Huckleberry (*Menziesia ferruginea*)*
Devil's Club (*Oplopanax horridium*)
Pachistima (*Pachistima myrsinites*)
Syringa (*Philadelphus lewisii*)
Ninebark (*Physocarpus malvaceus*)*
Bittercherry (*Prunus emarginata*)
Common Chokecherry (*Prunus virginiana*)
White Rhododendron (*Rhododendron albiflorum*)
Smooth Sumac (*Rhus glabra*)
Prickly Currant (*Ribes lacustre*)
Sticky Currant (*Ribes viscossissimum*)
Baldhip Rose (*Rosa gymnocarpa*)*
Nootka Rose (*Rosa nutkana*)
Pearhip Rose (*Rosa woodsii*)

Blackcap (*Rubus leucodermis*)
Western Thimbleberry (*Rubus parviflorus*)
Scouler Willow (*Salix scouleriana*)
Blue Elderberry (*Sambucus cerulea*)
Mountain Ash (*Sorbus scopulina*)
White spiraea (*Spiraea betulifolia*)*
Common Snowberry (*Symphoricarpos albus*)*
Creeping Snowberry (*Symphoricarpos mollis*)
Pacific Yew (*Taxus brevifolia*)
Blue Huckleberry (*Vaccinium globulare*)
Big Huckleberry (*Vaccinium membranaceum*)*

DWARF SHRUBS AND LOW WOODY PLANTS
Kinnikinnick (*Arctostaphylos uva-ursi*)*
Creeping Oregon Grape (*Berberis repens*)*
Twinflower (*Linnaea borealis*)*
Pacific Blackberry (*Rubus ursinus*)*
Yerba Buena (*Satureja douglasii*)
Dwarf Huckleberry (*Vaccinium caespitosum*)
Dwarf Bilberry (*Vaccinium myrtillus*)
Grouse Whortleberry (*Vaccinium scoparium*)

FERNS
Maidenhair Fern (*Adiantum pedatum*)
Ladyfern (*Athyrium filix-femina*)
Brittle Bladder-fern (*Cystopteris fragilis*)
Oak-fern (*Gymnocarpium dryopteris*)
Swordfern (*Polystichum munitium*)*
Bracken Fern (*Pteridium aquilinium*)*

GRASSES
Bluebunch Wheatgrass (*Agropyron spicatum*)*
Douglas' Brodiaea (*Brodiaea douglasii*)
Rattlesnake grass (*Bromus brizaeformis)*
Japanese brome (*Bromus japonicus*)
Softchess (*Bromus mollis*)
Cheatgrass (*Bromus tectorum*)*
Columbia Brome (*Bromus vulgaris*)*
Bluejoint reedgrass (*Calamagrostis canadensis*)
Pinegrass (*Calamagrostis rubescens*)*
Elk Sedge (*Carex geyeri*)*
Ross Sedge (*Carex rossii*)
Orchard Grass (*Dactylis glomerata*)*
Idaho Fescue (*Festuca idahoensis*)
Rough Fescue (*Festuca scabrella*)
Prairie June-grass (Koeleria cristata)

Small-flowered Woodrush (*Luzula parviflora*)
Bulbous Bluegrass (*Poa bulbosa*)
Kentucky bluegrass (*Poa pratensis*)
Sandberg Bluegrass (*Poa secunda*)

FORBS
Yarrow (*Achillea millefolium*)*
Monkshood (*Acontium columbianum*)
Baneberry (*Actea arguta*)
Pathfinder (*Adenocaulon bicolor*)*
Nettle-leaf Horse-mint (*Agastache urticifolia*)
Pearly-everlasting (*Anaphalis margaritacea*)*
Windflower (*Anenome piperi*)*
Sharptooth Angelica (*Angelica arguta*)*
Raceme Pussy-toes (*Antennaria racemosa*)
Spreading Dogbane (*Apocynum androsaemifolium*)*
Pale Blue Columbine (*Aquilegia cerulea var. ochroleuca*)
Rockcress (*Arabis* species)
Wild sarsaparilla (*Aralia nudicaulis*)*
Bigleaf Sandwort (*Arenaria macrophylla*)*
Heartleaf Arnica (*Arnica cordifolia*)*
Mountain Arnica (*Arnica latifolia*)*
Wild Ginger (*Asarum caudatum*)*
Showy Aster (*Aster conspicuus*)*
Arrowleaf Balsamroot (*Balsamorhiza sagittata*)*
Red Besseya (*Besseya rubra*)
Sego Lily (*Calochortus elegans*)
Green-banded Star Tulip (*Calochortus macrocarpus*)
Fairy-slipper (*Calypso bulbosa*)
Cusick's Paintbrush (*Castilleja cusickii*)*
Indian Paintbrush (*Castilleja hispida*)
Scarlet Paintbrush (*Castilleja miniata*)
Little Prince's Pine (*Chimaphila menziesii*)*
Prince's Pine (*Chimaphila umbellata*)
Alpine Circaea (*Circaea alpina*)
Bull Thistle (*Cirsium vulgare*)
Pink Fairies (*Clarkia pulchella*)
Spring Beauty (*Claytonia lanceolata*)
Columbia Clematis (*Clematis columbiana*)
Sugarbowls (*Clematis hirsutissima*)
Queenscup Beadlily (*Clintonia uniflora*)*
Blue-eyed Mary (*Collinsia parviflora*)
Spotted Coralroot (*Corallorhiza maculata*)
Striped Corralroot (*Corallorhiza striata*)
Western Goldthread (*Coptis occidentalis*)*
Bunchberry (*Cornus canadensis*)*

Hawksbeard (*Crepis* species)
Clustered Lady's-slipper (*Cypripedium fasciculatum*)*
White Lady's Slipper (*Cypripedium montanum*)
Larkspur (*Delphinium nuttallianum*)
Hooker Fairy-bell (*Disporum hookerii*)*
Wartberry Fairy-bell (*Disporum trachycarpum*)
Cusick's Shooting Star (*Dodecatheon cusickii*)
Shooting Star (*Dodecatheon pulchellum*)
Spring Draba (*Draba verna*)
Wyeth Buckwheat (*Eriogonum heracleoides*)*
Filaree (*Erodium cicutarium*)
Dog-tooth Violet (*Erythronium grandiflorum*)
Woods Strawberry (*Fragaria vesca*)*
Strawberries (*Fragaria* species)
Strawberry (*Fragaria virginiana*)*
Frasera (*Frasera albicaulis*)
Frasera (*Frasera fastigiata*)
Checker-lily (*Fritillaria lanceolata*)
Yellow Bells (*Fritillaria pudica*)
Blanket-flower (*Gaillardia aristata*)
Goose Grass (*Galium aparine*)*
Low Mountain Bedstraw (*Galium biflorum*)*
Northern Bedstraw (*Galium triflorum*)*
Prairie Gentian (*Gentiana affinis*)
Sticky Geranium (*Geranium viscossisimum*)
Prairie Smoke Avens (*Geum triflorum*)
Scarlet Gilia (*Gilia aggregata*)
Rattlesnake-plantain (*Goodyera oblongifolia*)*
Large-flowered Goldenweed (*Haplopappus carthamoides*)
Little-sunflower (*Helianthella uniflora*)
Roundleaf Alumroot (*Heuchera cylindrica*)
Western Hawkweed (*Hieracium albertinum*)
White-flowered Hawkweed (*Hieracium albiflorum*)*
Ballhead Waterleaf (*Hydrophyllum capitatum*)
Large Canadian St. John's-wort (*Hypericum majus*)
Common St. John's Wort (*Hypericum perforatum*)*
Western Blue Flag (*Iris missouriensis*)
Wild Sweet Pea (*Lathyrus latifolius*)
Canby's Licorice-root (*Ligusticum canbyi*)
Licorice-root (*Ligusticum verticillatum*)
Brown-leaved Toadflax (*Linaria genistifolia*)*
Twayblade (*Listera cordata*)
Prairie Star (*Lithophragma bulbifera*)
Puccoon (*Lithospermum ruderale*)
Biscuitroot (*Lomatium cous*)
Biscuitroot (*Lomatium dissectum*)

Biscuitroot (*Lomatium macrocarpum*)
Nine-leaf Lomatium (*Lomatium triternatum*)*
Orange Honeysuckle (*Lonicera ciliosa*)*
Velvet Lupine (*Lupinus leucophyllus*)*
Silky Blue Lupine (*Lupinus sericeus*)
Creeping Jenny (*Lysmachia nummularia*)
Alfalfa (*Medicago sativa*)*
Small Bluebells (*Mertensia longiflora*)
Leafy Bluebells (*Mertensia oblongifolia*)
Tall Bluebells (*Mertensia paniculata*)
Microsteris (*Microsteris gracilis*)
Alpine mitrewort (*Mitella pentandra*)
Side-flowered Mitrewort (*Mitella stauropetala*)*
Indian-pipe (*Monotropa uniflora*)*
Miner's Lettuce (*Montia perfoliata*)
Forget-me-not (*Myosotis laxa*)
Mountain Sweet-root (*Osmorhiza chilensis*)*
Bracted Lousewort (*Pedicularis bracteosa*)
Leafy Lousewort (*Pedicularis racemosa*)
Beardstongue (*Penstemon* species)
Taper-leaved Penstemon (*Penstemon attenuatus*)
Wilcox's Beardstongue (*Penstemon wilcoxii*)
Long-leaved Phlox (*Phlox longifolia*)
English Plantain (*Plantago lanceolata*)
Jacob's Ladder (*Polemonium pulcherrimum*)
Cinquefoil (*Potentilla flabellifolia*)
Sticky Cinquefoil (*Potentilla glandulosa*)*
Slender Cinquefoil (*Potentilla gracilis*)*
Selfheal (*Prunella vulgaris*)
Pinedrops (*Pterospora andromedea*)*
Common Pink Wintergreen (*Pyrola asarifolia*)
One-sided Wintergreen (*Pyrola secunda*)
Early Buttercup (*Ranunculus glaberrimus*)
Sorrel (*Rumex acetosella*)
Small Burnet (*Sanguisorba minor*)
Swamp Saxifrage (*Saxifraga integrifolia*)
Stonecrop (*Sedum lanceolatum*)
Wormleaf Stonecrop (*Sedum stenopetalum*)*
Western Groundsel (*Senecio integerrimus*)
Arrowleaf Goundsel (*Senecio triangularis*)
Grass-widow (*Sisyrinchium inflatum*)
False Solomon's Seal (*Smilacina racemosa*)*
Starry Solomon Seal (*Smilacina stellata*)*
Twisted-stalk (*Streptopus amplexifolius*)
Mountain Kittentails (*Synthyris missurica*)
Evergreen Synthyris (*Synthyris platycarpa*)

Common Tansy (*Tanacetum vulgare*)*
Common Dandelion (*Taraxacum officinale*)
Western Meadowrue (*Thalictrum occidentale*)*
Three-leaved Coolwort Foamflower (*Tiarella trifoliata*)
Coolwort Foamflower (*Tiarella unifoliata*)*
Goatsbeard (*Tragopogon dubius*)
False Bugbane (*Trautvetteria caroliniensis*)
White Trillium (*Trillium ovatum*)*
Sitka Valerian (*Valeriana sitchensis*)
Ventenata (*Venteata dubia*)
American False Hellebore (*Veratrum viride*)
Mullen (*Verbascum thapsus*)*
American Vetch (*Vicia americana*)*
Hook Violet (*Viola adunca*)
Pioneer Violet (*Viola glabella*)
Round-leaved Violet (*Viola orbiculata*)*
Northern Mule's Ear (*Wyethia amplexicaulis*)
Beargrass (*Xerophyllum tenax*)
Death Camas (*Zigadenus venenosus var gramineus*)

EXOTICS
Diffuse Knapweed (*Centaurea diffusa*)
Spotted Knapweed (*Centaurea maculosa*)*
Canada Thistle (*Cirsium arvense*)
Meadow Hawkweed (*Hieracium pratense*)
Dalmatian Toadflax (*Linaria genistifolia ssp. dalmatica*)
Yellow Toadflax (*Linaria vulgaris*)
Scotch Thistle (*Onopordum acanthium*)

NOTE: * signifies present or sampled

APPENDIX B: POTENTIAL WILDLIFE SPECIES FOR EACH PLANT COMMUNITY TYPE WITHIN FARRAGUT STATE PARK

1. GRASS AND SPOTTED KNAPWEED COMMUNITY TYPE

AMPHIBIANS AND REPTILES
Long-toed Salamander
Northern Alligator Lizard
Racer (Forest edge)

BIRDS
Great Blue Heron
Wood Duck
Harlequin Duck
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
Blue Grouse
Ruffed Grouse
Bonaparte's Gull
Flammulated Owl
Great-horned Owl
Northern Pygmy Owl (Forest edge)
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird
Lewis Woodpecker
Red-naped Sapsucker
Williamson's Sapsucker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker

Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond's Flycatcher
Gray Jay
Steller's Jay
Clark's Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend's Solitaire
Swainson's Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend's Warbler
MacGillivray's Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill
White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk

Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Elk
White-tailed Deer
Moose

2. GRASS, SPOTTED KNAPWEED, AND TREE SAPLING COMMUNITY TYPE

AMPHIBIANS AND REPTILES
Long-toed Salamander
Northern Alligator Lizard
Racer (Forest edge)

BIRDS
Great Blue Heron
Wood Duck
Harlequin Duck
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
Blue Grouse
Ruffed Grouse
Bonaparte's Gull
Flammulated Owl
Great-horned Owl
Northern Pygmy Owl (Forest edge)
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird

Lewis Woodpecker
Red-naped Sapsucker
Williamson's Sapsucker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond's Flycatcher
Gray Jay
Steller's Jay
Clark's Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend's Solitaire
Swainson's Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend's Warbler
MacGillivray's Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill
White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Elk
White-tailed Deer
Moose

3. TREE SAPLING COMMUNITY TYPE

AMPHIBIANS AND REPTILES
Long-toed Salamander
Northern Alligator Lizard
Racer

BIRDS
Great Blue Heron
Wood Duck
Harlequin Duck
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
Blue Grouse
Ruffed Grouse
Bonaparte's Gull
Flammulated Owl

Great-horned Owl
Northern Pygmy Owl
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird
Lewis Woodpecker
Red-naped Sapsucker
Williamson's Sapsucker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond's Flycatcher
Gray Jay
Steller's Jay
Clark's Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend's Solitaire
Swainson's Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend's Warbler
MacGillivray's Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill

White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Elk
White-tailed Deer
Moose

4. LODGEPOLE PINE AND DOUGLAS-FIR FOREST COMMUNITY TYPE

AMPHIBIANS AND REPTILES
Long-toed Salamander
Western Toad (Near water)
Pacific Chorus Frog (Near water)
Western Skink (Near water)
Northern Alligator Lizard
Common Garter Snake (Near water)
Western Terrestrial Garter Snake (Near water)
Rubber Boa (Near water)
Racer

BIRDS
Great Blue Heron
Black-crowned Night Heron (Near water)
Wood Duck
Harlequin Duck
Common Goldeneye

Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
Blue Grouse
Ruffed Grouse
Bonaparte's Gull
Flammulated Owl
Great-horned Owl
Northern Pygmy Owl
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird
Lewis Woodpecker
Red-naped Sapsucker
Williamson's Sapsucker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond's Flycatcher
Gray Jay
Steller's Jay
Clark's Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend's Solitaire

Swainson's Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend's Warbler
MacGillivray's Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill
White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Water Shrew (Near streams)
Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Mink (Near streams, rivers, and lakes)
River Otter (Near streams and lakes)
Elk
White-tailed Deer
Moose

5. DENSE, DRY FOREST (PONDEROSA PINE, WESTERN LARCH, DOUGLAS FIR, AND GRAND FIR) COMMUNITY TYPES

AMPHIBIANS AND REPTILES
Long-toed Salamander
Western Toad (Near water)
Pacific Chorus Frog (Near water)
Western Skink (Near water)
Northern Alligator Lizard
Common Garter Snake (Near water)
Western Terrestrial Garter Snake (Near water)
Rubber Boa (Near water)
Racer

BIRDS
Great Blue Heron
Black-crowned Night Heron (Near water)
Wood Duck
Harlequin Duck
Common Goldeneye
Barrow's Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle
Sharp-shinned Hawk
Cooper's Hawk
Northern Goshawk
Red-tailed Hawk
Peregrine Falcon (Cliffs)
Blue Grouse
Ruffed Grouse
Bonaparte's Gull
Flammulated Owl
Great-horned Owl
Northern Pygmy Owl
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird
Lewis Woodpecker
Red-naped Sapsucker
Williamson's Sapsucker
Hairy Woodpecker

Black-backed Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond’s Flycatcher
Gray Jay
Steller’s Jay
Clark’s Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend’s Solitaire
Swainson’s Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend’s Warbler
MacGillivray’s Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill
White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Water Shrew (Near streams)

Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Mink (Near streams, rivers, and lakes)
River Otter (Near streams and lakes)
Elk
White-tailed Deer
Moose

6. DENSE, WET, MIXED CONIFER FOREST (PONDEROSA PINE, LODGEPOLE PINE, WESTERN WHITE PINE, WESTERN LARCH, DOUGLAS FIR, GRAND FIR, WESTERN REDCEDAR, AND WESTERN HEMLOCK) COMMUNITY TYPES

AMPHIBIANS AND REPTILES
Long-toed Salamander
Western Toad (Near water)
Pacific Chorus Frog (Near water)
Western Skink (Near water)
Northern Alligator Lizard
Common Garter Snake (Near water)
Western Terrestrial Garter Snake (Near water)
Rubber Boa (Near water)
Racer

BIRDS
Great Blue Heron
Black-crowned Night Heron (Near water)
Wood Duck
Harlequin Duck
Common Goldeneye
Barrow’s Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
Turkey Vulture
Bald Eagle

Sharp-shinned Hawk
Cooper’s Hawk
Northern Goshawk
Red-tailed Hawk
Blue Grouse
Ruffed Grouse
Bonaparte’s Gull
Flammulated Owl
Great-horned Owl
Northern Pygmy Owl
Barred Owl
Northern Saw-Whet Owl
Vaux Swift
Calliope Hummingbird
Rufous Hummingbird
Lewis Woodpecker
Red-naped Sapsucker
Williamson’s Sapsucker
Hairy Woodpecker
Three-toed Woodpecker
Black-backed Woodpecker
Northern Flicker
Pileated Woodpecker
Olive-sided Flycatcher
Western Wood Pewee
Hammond’s Flycatcher
Gray Jay
Steller’s Jay
Clark’s Nutcracker
Black-billed Magpie
Common Raven
Mountain Chickadee
Chestnut-backed Chickadee
Red-breasted Nuthatch
White-breasted Nuthatch
Brown Creeper
Winter Wren
Golden-crowned Kinglet
Ruby-crowned Kinglet
Townsend’s Solitaire
Swainson’s Thrush
Varied Thrush
Cedar Waxwing
Solitary Vireo
Yellow-rumped Warbler
Townsend’s Warbler

MacGillivray's Warbler
Western Tanager
Black-headed Grosbeak
White-throated Sparrow
White-crowned Sparrow
Dark-eyed Junco
Brown-headed Cowbird
Red Crossbill
White-winged Crossbill
Common Redpoll
Pine Siskin
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew
Dusky Shrew
Vagrant Shrew
Water Shrew (Near streams)
Big Brown Bat
Silver-haired Bat
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
Porcupine
Black Bear
Marten
Ermine
Mink (Near streams, rivers, and lakes)
River Otter (Near streams and lakes)
Elk
White-tailed Deer
Moose

7. HUMAN HABITATS

AMPHIBIANS AND REPTILES
Long-toed Salamander
Western Toad (Near water)
Pacific Chorus Frog (Near water)
Western Skink (Near water)
Northern Alligator Lizard
Common Garter Snake (Near water)

Western Terrestrial Garter Snake (Near water)
Rubber Boa (Near water)
Racer (Forest edge)

BIRDS
American Kestrel
Gray Partridge (Fences)
Ring-necked Pheasant (Fences)
Rock Dove
Western Screech-owl (Shade trees)
Northern Pygmy Owl (Fences & telephone poles)
Common Nighthawk
Black-chinned Hummingbird
Olive-sided Flycatcher
Western Wood Pewee (Shade trees)
Western Flycatcher (Beams inside of sheds & barns)
Say's Phoebe (Buildings)
Violet-green Swallow (Buildings)
Northern Rough-winged Swallow (Buildings)
Cliff Swallow (Buildings)
Barn Swallow (Buildings)
Clark's Nutcracker
American Crow
Chestnut-backed Chickadee (Shade trees)
House Wren (Buildings)
Mountain Bluebird
American Robin
Varied Thrush
Bohemian Waxwing
Cedar Waxwing
Warbling Vireo
American Tree Sparrow
Northern Oriole
House Finch
Red Crossbill
Common Redpoll
Pine Siskin
American Goldfinch
Evening Grosbeak
House Sparrow

MAMMALS
Masked Shrew (Moist forests)
Dusky Shrew (Moist forests)
Vagrant Shrew (Moist areas)
Big Brown Bat (Buildings)

Silver-haired Bat (Wet or dry forests)
Townsend's Big-eared Bat (Buildings)
Snowshoe Hare
Red-tailed Chipmunk
Red Squirrel
Northern Flying Squirrel
Deer Mouse
House Mouse
Coyote
Red Fox
Black Bear
Raccoon
Ermine
Long-tailed Weasel
Striped Skunk
White-tailed Deer

APPENDIX C: GLOSSARY

Aspect: The direction a slope is facing (e. g., north, east, south, etc.)

Association: An abstract climax plant community type in which all component patches are comprised of the same vegetation layers with limited variability in species composition and in habitat conditions (Cooper et al 1991).

Attribute: Non-graphic descriptors of point, line and polygon features in a GIS system (DeMers 1997).

Basal area: The cross-sectional area of the trunk of a tree at breast height (Cooper et al 1991). This measurement is summed for all trees in a given forest patch.

Breast height: 4.5 ft. above the ground (Walstad et al. 1990).

Canopy: The tree crowns in a forest patch (Walstad et al. 1990).

Canopy cover or coverage: The area covered when an imaginary polygon is circumscribed about a plant's foliage and projected to a horizontal plane and expressed as a percentage of the sampling unit (Cooper et al. 1991).

Classification accuracy: The accuracy of attributes, classes or map feature identifiers.

Clear-cut: A reproduction method in which the entire forest patch is removed in one cutting with reproduction obtained artificially or by natural seeding from adjacent patches or from trees cut in the clearing operation (Osborne 1997).

Climax: The culminating stage in plant succession for a given habitat. This stage develops and perpetuates itself with the absence of disturbance (Cooper et al. 1991).

Community type: A homogeneous assemblage of plant species occurring in a defined area and recognized as a distinct unit.

Crown fire: A fire that advances through the canopy of a forest and is sometimes associated with an intense surface fire (Agee 1993).

Database: A collection of spatial data and related descriptive data organized for efficient storage and retrieval by many users (Environmental Systems Research Institute, Inc. 1990).

DBH: Diameter of a tree at breast height (Walstad et al. 1990).

Density: The number of trees per unit area (Walstad et al. 1990).

Depauperate: Sparse understory of vegetation, usually caused by dense forest canopies and/or a deep duff layer (Cooper et al. 1991).

Digital Elevation Model: Digital model of landform data (DeMers 1997).

Duff: The layer of partially and fully decomposed organic materials lying below the litter and immediately above the mineral soil (Walstad et al. 1990).

Ecosystem: The interaction of organisms, physical environments, and their linkage and connectivity to other communities and physical environments (Neuenschwander 1995).

Felling: The practice of cutting timber (Walstad et al. 1990).

Fine fuels: Fuels that ignite readily and are consumed rapidly by fire. These fuels consist of cured grass, fallen leaves, needles, and small twigs < 0.25 inches in diameter (Walstad et al. 1991).

Fire exclusion: The suppression and prevention of fire within plant communities and ecosystems.

Fire frequency: The lapse time between fires (Neuenschwander 1995).

Fire intensity: The rate of heat energy release per unit time per unit length of the fire front (Walstad et al. 1990).

Fire regime: The spatial patterns created by fires over time. It is the inclusive historical fire frequency, intensity, severity, size, and landscape pattern. Fire regimes vary with forest and range type, location, succession stage, fuel condition, climate, soils, landform, and ignition frequency and distribution (Neuenschwander 1995).

Fire scar: healing or healed injuries, caused or aggravated by fire, on a woody plant (Agee 1993).

Fire severity: The total organic matters consumed and subsurface soil heating. Severity is directly related to the consumption of duff and dead fuel and/or heat penetration and temperature in the soil (Neuenschwander 1996).

Forb: An herbaceous plant that is not a graminoid (Cooper et al. 1991).

Fuel: Any substance or composite mixture susceptible to ignition and combustion (Walstad et al. 1990).

Fuel break: Any natural or constructed barrier utilized to segregate, stop, and control the spread of fire (Walstad et al. 1990).

Fuel ladder: A vertical continuity in fuels between the ground and crown of a forest (Walstad et al. 1990).

Fuel load: The dry weight of combustible materials per unit area (Walstad et al. 1990).

Fuel management: The planned manipulation and reduction of living and dead forest fuels (Walstad et al. 1990).

Fuel model: A set of numbers that define fuel input to a fuel spread model.

Geographic information systems: An organized collection of computer hardware, software, geographic data, and personnel designed to capture, store, update, manipulate, analyze, and display geographically referenced information (Environmental Systems Research Institute, Inc. 1990).

GIS: See Geographic Information Systems.

Global positioning system: A global navigation system based on a constellation of 24 satellites orbiting the Earth at a very high altitude. The system can record location (X, Y, Z) and ancillary data for portions of the earth (Hurn 1989, DeMers 1997).

Glowing combustion zone: The area between the flaming combustion zone and the extinction of fire, including areas with glowing, smoldering, and flickering fire. This zone is closely linked to root damage (Neuenschwander 1995)

GPS: See Global Positioning System.

Graminoid: All grasses, sedges, rushes and grass like plants (Cooper et al. 1991).

Habitat type: All land areas potentially capable of producing similar plant communities at climax (Cooper et al. 1991).

Hazard reduction: The planned treatment of naturally growing vegetation and forest fuels for the purpose of reducing the rate of spread and the output of heat energy from a wildfire (Walstad et al. 1990).

Historical range of variability: An ecosystem's amplitude of historical succession responses to perturbations or disturbances over time. It should identify the resistance and resilience of an ecosystem (Neuenschwander 1995).

HRV: See historical range of variability.

Improvement cut: Cuts made in forest patches past the sapling stage for the purpose of improving species composition, form and growth (Osborne 1997). The primary objective is the elimination of undesired species (e. g., Douglas fir and grand fir on ponderosa pine sites).

Initial floristics: A process of succession where seeds or plants of latter succession stages are present from the outset but are subordinate to other species (Agee 1993).

Lattice: A series of point locations whose interspatial distances are identical (DeMers 1997).

Map resolution: Accuracy with which the location and shape of map features are depicted for a given map scale (Environmental Systems Research Institute, Inc. 1990).

Map scale: A statement of a measure on the map and the equivalent measure on the earth, often expressed as a representative fraction of distance, such as 1:24,000. This means that one unit of distance on the map represents 24,000 of the same units of distance on the earth (Environmental Systems Research Institute, Inc. 1990).

Metadata: Data about data. Documentation providing the history (scale, resolution, how it was made, when it was made, who made it, etc.) of a particular piece of spatial or attribute data.

Mineral soil: The layer of soil beneath the duff (Walstad et al. 1990).

Minimum mapping unit: The acceptable lower limit in patch size or maxium allowable error in the position of data.

Organic matter: Material consisting or derived from living organisms. In soil, organic matter is the more or less decomposed residue of plants and animals called humus (Walstad et al. 1990).

Overlay: A process that merges overlapping polygons and their attributes from two maps to create a third map of new polygons (Environmental Systems Research Institute, Inc. 1990).

Particulate: A compound of polluted air consisting of any liquid or solid particles suspended in or falling through the atmosphere (Walstad et al. 1990).

Patch: An area that is homogenous in some characteristic of interest so that it can be distinguished from neighboring areas.

Phase: A subdivision of habitat type representing minor differences in climax vegetation that may reflect environmental differences, floristic peculiarities or historic peculiarities within the habitat type (Cooper et al. 1991).

Prescribed burn or fire: The controlled application of fire to wildland fuels under conditions that allow the fire to be contained to a designated area (Walstad et al. 1990).

Raster: A GIS graphic data structure that stores spatial information in a series of uniformly spaced cells (DeMers 1997).

Rate of spread: The rate at which the flaming front moves (Neuenschwander 1995).

Relational database: The linkage of attribute data with other attribute data or with spatial data through a common item.

Resilience: The tendency to return after perturbation or disturbance to the former ecosystem and its structure and function (Neuenschwander 1995).

Resistance: The tendency to remain unchanged in the face of perturbation or disturbance (Neuenschwander 1995).

Resolution: The amount of the earth's surface represented by a single raster cell (DeMers 1997).

Restoration: The return of native plant community composition, structure and processes to disturbed or altered areas.

Runoff: The natural drainage of water away from an area. It includes both surface and subsurface flow (Walstad et al. 1990).

Scarification: Disturbing the topsoil in preparation for natural regeneration, direct seeding or planting (Walstad et al. 1990).

Seral: A species or community that is replaced by another species or community during succession (Cooper et al. 1991).

Series: A group of habitat types having the same potential climax tree species (Cooper et al. 1991).

Skid trail: Trail used to drag logs from their point of harvest to a loading area.

Slash: The un-merchantable residue left on the ground after logging, thinning or other forest operations. Slash consists of treetops, branches, defective logs, bark, chips, uprooted stumps, and felled shrubs and noncommercial trees (Walstad et al. 1990).

Slope: The degree of incline of a land surface in relation to a horizontal plane.

Snag: A standing dead tree from which the leaves and most of the branches have fallen (Walstad et al. 1990).

Spatial data: Information about the location, shape, and relationships among geographic features, usually stored as coordinates and topology (Environmental Systems Research Institute, Inc. 1990).

Succession: The changes in the biota or plant communities of a given area relative to a previous state. The changes are usually to a hypothetical equilibrium point called climax (Cooper et al. 1991).

Surface erosion: The loss of upper layers of the soil profile due to the action of wind, water, or gravity (Walstad et al. 1990).

Surface fire: A fire that burns in the surface fuel layer and not the tree crowns. This fire type burns as a head fire; backfire or flank fire (Agee 1993).

Thinning: An intermediate treatment applied to even-aged patches or even-aged groups in uneven-aged patches where the objective is to maintain tree and patch vigor, capture impending mortality and redistribute site resources toward the residual trees. This operation can be conducted at any time during the life of the forest patch (Osborne 1997).

Understory: The trees, seedlings, saplings, shrubs, grasses and forbs that grow under the overstory trees.

Waterbar: A small berm constructed across a potential water channel to divert runoff and thereby minimize erosion (Walstad et al. 1990).

Yarding: The operation of the initial haul of cut timber or logs to a collecting point with cable equipment (Walstad et al. 1990).